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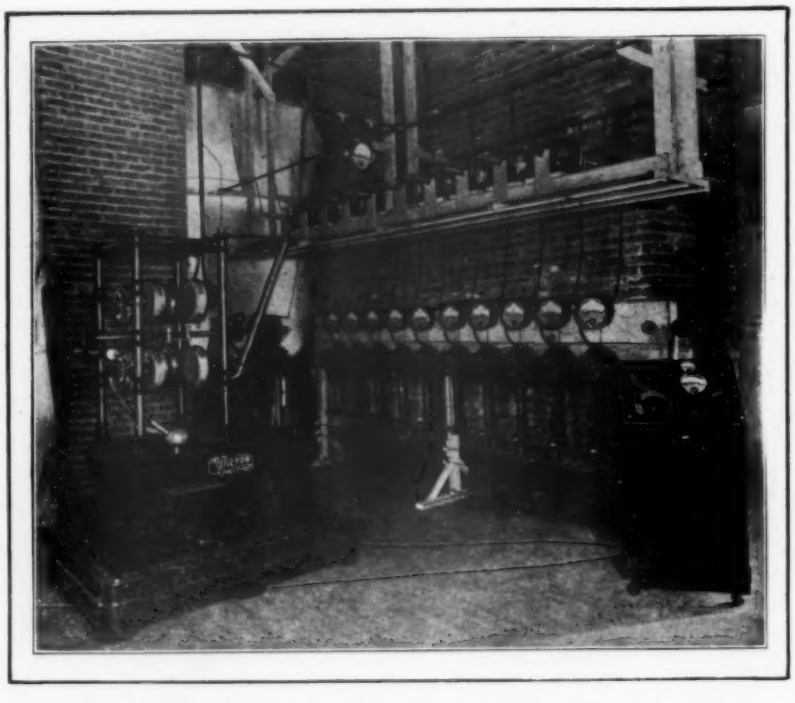

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Roentgenologic Signs of Cancer of the Colon*

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ROENTGENOLOGIC diagnosis of cancer of the colon presents certain difficulties and apparently has not progressed comparably with the roentgenologic diagnosis of other diseases of the alimentary tract. It may be profitable, therefore, to review some of the accepted facts and summarize the findings in a series of 359 cases examined by the roentgen ray and operated on at the Mayo Clinic. Cancers of the rectum and rectosigmoid are not included in the series.

Pathology

From a pathologic standpoint, cancer of the colon offers few peculiarities. Histologically, the same forms are found as in the stomach, namely, the cylindrical-celled adenocarcinoma; the small-celled, soft, medullary form; the hard, scirrhous variety, and the mucoid or colloid carcinoma. Soft, medullary cancers grow rapidly, sometimes attain considerable size, and may slough deeply. Scirrhous cancers are often small, tend to encircle the bowel, producing the well-known stenotic, napkin-ring form, and are only superficially ulcerated. Most writers generally consider the flexures and narrowings of the colon to be the favorite sites of cancer; statistics indicate a marked predilection for the sigmoid flexure. Lane asserts that the common situations are at those points of the bowel where its lumen is constricted by acquired adhesions or by muscular spasm, namely: (1) in the ascending colon at or about the level of the crest of the ilium, (2) in the transverse colon to the left of the hepatic flexure, (3) at the splenic flexure, (4) in the descending colon at about the level of the iliac crest, (5) at the juncture of the pelvic and iliac segments, and (6) around the rectal sphincters.

Cancer of the colon differs from cancer of the stomach in that metastasis from the former is far less common. As pointed out by C. H. Mayo, the reason for this probably lies in the distribution of the lymphatics which are limited as compared with those of the stomach or small bowel. Necropsies have shown that in as many as 50 per cent of patients dying of malignancy of the colon the disease remains local, death being due to obstruction, perforation or peritonitis. However, in young persons the lymphatics are more active and there is earlier distribution of the disease; this is true also of cancer of the transverse colon.

Technique

For eliciting roentgenologic evidences of colonic cancer, both the opaque meal and the opaque enema have been employed. Although the meal is still used to some extent, it has been largely superseded by the enema. The meal has the disadvantage of tending to accumulate in the proximal or distal portions of the colon, and repeated observation at intervals is required to visualize the intervening segments. The bariumized mass does not fill out a segment uniformly, but often strings out irregularly, or is broken up into detached masses. Haustration is present, but may be more marked in one segment than another; it is not uniform, and pathologic alterations of contour are not readily distinguished (Fig. 1). However, the meal may be used as an adjunct to the enema and may be an aid in the detection of cecal lesions.

Advantages of the enema are that it visualizes the colon throughout or to the point of obstruction, the colonic walls are expanded to normal or beyond, so that irregularities of contour are more readily seen, and it is possible to complete the examination within a few minutes (Fig. 2). Schlesinger says that since employing the enema he has often been able to demonstrate cancers with such slight symptoms that a malignant growth would hardly have been suspected.

For several years our routine at the Clinic has not varied. On the evening before examination the patient abstains from supper and takes 60 c.c. of castor oil; early the next morning he clears out the bowel with a warm soapsuds enema. The opaque enema is made up of 240 gm. of barium sulphate held in suspension by condensed milk and mucilage of acacia, the total quantity being about 2 liters. This is warmed to body temperature, and, with the patient recumbent on the trochoscope, is admin-

*—Read at the Annual Meeting of the Radiological Society of North America, December 5th, 1922, Detroit.

Fig. 1—(Case A-19406)—Ingested meal. Irregular distribution of barium throughout the colon. No definite obstruction, but peculiar irregularity of descending colon and sigmoid, suggesting a lesion. See Figure 2.
Fig. 2—(Case A-19406)—Definite obstruction to enema in the sigmoid flexure. At operation cancer of the sigmoid was found.
Fig. 3—(Case A-350027)—Cancer of the lower sigmoid. Note the annular filling defect.
Fig. 4—(Case A-68010)—Napkin-ring cancer of the transverse colon.

istered from a container at a height of 0.5 to 1 m. The enema is watched on the screen from the moment it enters until filling is complete, and the abdomen is manipulated as is necessary to assist observation. One or several plates are made for confirmation, supplementary study, or permanent record, but a diagnosis is never attempted on roentgenographic findings alone (Figs. 3, 4 and 5).

Roentgenologic Signs

Roentgenologic manifestations of cancer of the colon, as elicited by the opaque enema, are few and simple. Practically there are but two of importance, namely the filling defect and obstruction.

The filling defects observed vary widely in size and contour, depending on the size and conformation of the growth. Ordinarily, they are occasioned by the intrusion of the tumor into the intestinal lumen, but sometimes they are caused by infiltrative stiffening of the intestinal wall so that it does not expand under pressure of the enema, as does the adjacent uninvolved portion of the bowel. In some instances, also, the deformity is probably increased by local spasm excited by the lesion. Fecal accumulations proximal to an obstructive cancer may also exaggerate the filling defect.

Incomplete obstruction due to cancer may produce some retardation of the clysmal current at the point of stenosis. Unless there is also an evident filling defect at this point the examiner will not usually be able to distinguish this slowing of the enema from that which often occurs under normal conditions. Surgeons of the Clinic have observed that a marked stenosis may be found at operation even though the roentgenologist may not have noted obstruction to the enema. On the other hand, a stenosis which permits the fecal stream to pass in the physiologic direction may absolutely block the enema. One explanation of this eccentricity is that the stenosis is accustomed to the passage of the meal in the proper direction and accommodates itself accordingly; another is that the rapidly entering enema sets up a spasm which closes the already narrowed channel. The enema may terminate at the place of obstruction in a conical projection, or be rounded off bluntly. In the latter instance, as Schlesinger has shown, the actual site of obstruction may be concealed by the distended, overhanging end of the bowel; by changing the position of the patient, or by manipulation, the spicule-like termination may be brought into view.

If the stenosis is marked, but pervious to the enema, the bowel proximal to the lesion may show some dilatation, which is a natural sequence of the obstruction. Moynihan says that wherever the obstruction may be situated, the cecum distends to a greater degree than any other part.

Palpation for masses, although within the clinical field, is also a necessary part of the roentgenologic examination in order to determine not only their presence, but also their relation to shadowed changes in the colon. A mass corresponding to a filling defect, or a point of obstruction, increases the certainty that a lesion of the colon is present, although not necessarily a cancer. Furthermore, with the outline of the colon before him, the examiner can palpate with greater exactness than can the clinician. While the examiner thus has to deal with virtually the same phenomena as in cancer of the stomach, it is less easy to discover and to interpret them in the colon. The normal stomach has smooth contours, unbroken except by traveling peristalsis. The area to be studied is not extensive, is in plain view, and, by turning the patient, can be easily inspected at various angles, so that even relatively small lesions are not likely to escape notice. Gastric cancer has its simulants in syphilis, benign tumors, and simple ulcers, but the examiner can often exclude these with reasonable assurance.

On the other hand, the colon presents a far greater area for investigation. The pelvic colon is often more or less concealed by its own loops and is inaccessible to palpation because of the pubic symphysis. The rami of the flexures often cast an overlapping shadow. Slight local irregularities due to localized spasm, haustral tonus, external or internal pressure, are so common normally that it is unsafe to regard them seriously. Simulants of cancer are numerous and can seldom be dismissed from consideration on roentgen signs alone.

Interpretation

Given a filling defect, obstruction, or other abnormality, interpretation requires a careful process of exclusion. First, it must be assured that the signs are due to intrinsic, pathologic causes. Apparent filling defects may be produced by gas in the bowel or air introduced with the enema, or by pressure of the spine at the point where it is crossed by the transverse colon. After filling the bowel the upper sigmoid is likely to show a hiatus, either from tonic contraction of the bowel or from pressure against the pelvic brim. Tumors outside the colon may indent its outline; manipulation will usually determine the fact. If the quantity of the enema is too small it may distribute itself irregularly; care should be taken that the amount is adequate.

Obstruction should not be too hastily assumed, for under normal conditions the enema often advances at irregular speed and is retarded somewhat at the flexures. Dilatation should be judged cautiously, and the normal greater width of the cecum and proximal colon kept in mind.

Spasm, the arch deceiver in gastric diagnosis, occurs also in the colon. More often it affects the distal portions which are so narrowed and deeply haustrated that the spasticity is apparent. Occasionally, the spasm involves only a limited area, is quite persistent, and the filling defect or narrowing which

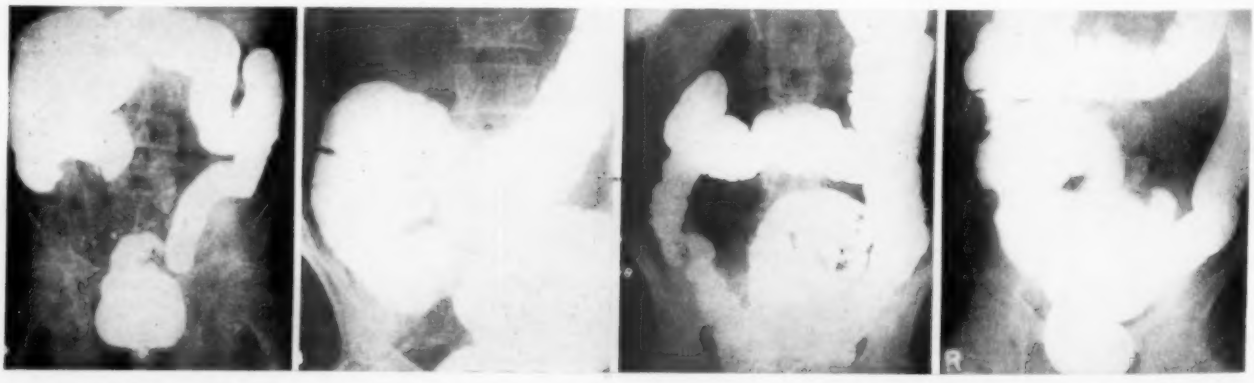

Fig. 5—(Case A-283029)—Cancer of the cecum. Note the narrowing in the sigmoid due to spasm.
Fig. 6—(Case A-99125)—Spasm of the transverse colon near the hepatic flexure, simulating organic disease.

Fig. 7—(Case A-285818)—Tuberculosis of the cecum and of the ascending colon.

Fig. 8—(Case A-278991)—Actinomycosis of the cecal wall.

results is much like that of an organic lesion (Fig. 6). No mass corresponding to the defect can be felt and the enema is not obstructed at that point; these discrepancies may put the examiner on guard. Whenever spasm is suspected antispasmodics should be given to physiologic effect and the examination repeated. Usually the spasm will be relaxed by the drug.

When all such deceptive factors can be excluded and the existence of an intrinsic lesion is definitely established, the examiner can rarely venture an opinion that the lesion is cancer, for a number of pathologic conditions give similar findings. In the cecum and proximal bowel, tuberculosis, whether of the ulcerative or the hypertrophic type, often has a striking resemblance to cancer, although absence of tuberculous lesions from the lung has some exclusion value in the latter case (Fig. 7). Assmann remarks that it may be difficult to distinguish tuberculosis from cancer even at autopsy. Actinomycosis, appendiceal abscess and abscesses of the cecal wall may distort the cecal contour (Figs. 8 and 9). Typical, diffuse ulcerative colitis with its extensive involvement and its smooth, uniform narrowing of the intestinal lumen, will hardly be confounded with cancer, but if the condition is circumscribed in extent it cannot be distinguished from cancer with any degree of certainty (Fig. 10).

Peridiverticulitis is a vexing simulant of cancer. More often it is found in the sigmoid, or at least distal to the hepatic flexure, and is characterized by a local filling defect with perhaps a palpable mass and a few projecting, barium-filled diverticula. Often the deformity of the bowel is not due solely to the lesion, but is accentuated by spasm. Our observations with the roentgen ray accord with W. J. Mayo's statement that as a rule the obstruction from peridiverticulitis is not quite complete. Barium-filled diverticula in the distorted area, or elsewhere in the bowel, may aid in identifying the condition, but they are not always demonstrable. On the other hand, the irregularities of a cancerous lumen sometimes resemble diverticula. Further, 20 per cent or more of the cases of peridiverticulitis develop cancer (Mayo, Wilson). Thus an absolute differentiation is often impossible (Fig. 11).

In our experience, adhesions resulting from inflammatory disease or surgical operations, have not commonly caused either obstruction or evident deformity of the bowel. Indeed, the intestine may be well matted in adhesions without any definite changes in the roentgenologic picture. In a few instances, however, obstruction or irregularity of the intestinal outline from this cause have been noted (Figs. 12 and 13).

Besides cancer, the colon may be the seat of sarcoma, especially lymphosarcoma, or of various benign new growths. Primary sarcoma is rare, and, of course, occurs more often in younger persons. Benign tumors include myoma, lipoma, hemangioma, lymphangioma, and the tumor-like swellings incident to leukemia and pseudoleukemia. Obviously, the roentgenologist cannot be expected to distinguish cancer from any of them, but, notwithstanding their variety, the proportion of these cases to cancer is quite small. Polypose or papillary adenomas are more common. Usually they are small and multiple. Polyposis may extend throughout the small and large intestine, but its preferred location is the lower sigmoid (Mayo).

In one of the cases of polyposis apparent low obstruction was revealed at the first examination; on reexamination the bowel filled throughout, but gave a mottled shadow, not at all suggestive of cancer.

Intussusception may be a complicating factor of cancer. In a case examined with the roentgen ray by Karewski a cancer of the descending colon had caused an invagination into the sigmoid.

Lockhart-Mummery and others have emphasized the fact that in tumors of the colon the roentgenologic findings are often negative. In 9.2 per cent of the cases herewith reported the roentgen examiner failed to discover any signs of a lesion, a higher proportion of negative errors than in cancer of the stomach. The principal reason for this unfavorable comparison probably is due to the fact that a relatively minute alteration of the gastric outline is often a sufficient basis for diagnosis, while in the colon small irregularities are likely to be meaningless. Non-obstructive lesions in the pelvic colon, or at the flexures, may escape detection. Normal variations in the length and configuration of the cecum and ascending colon are sometimes hard to distinguish from pathologic changes. I recall one instance in which this part of the colon seemed rather short, but its outline was quite regular and the condition was regarded simply as a "high cecum." At operation a cecal cancer was found.

In deciding the question of operability, greater latitude is permissible than in cancer of the stomach. When the roentgen ray reveals an extensive cancer of the cardia, resection is seldom feasible. But cancers of the colon, however extensive and wherever situated, are not necessarily inoperable. Metastasis is often limited or absent. Attachment to a neighboring viscus, if conditions are otherwise favorable, does not necessarily forbid operation (W. J. Mayo).

Series of Cases

In the Clinic, from January 1, 1915, to the present, 359 cases of cancer of the colon which had been examined by the roentgen ray went to operation. Men outnumbered the women by more than two to one, with 242 of the former and 117 of the latter. While chiefly the middle and later decades of age were represented, it is noteworthy that no less than seven of the patients

Fig. 9—(Case A-228330)—Appendiceal abscess deforming the cecal outline.
Fig. 10—(Case A-241349)—Localized ulcerative colitis of the splenic flexure.
Fig. 11—(Case A-270441)—Peridiverticulitis of the sigmoid.
Fig. 12—(Case A-121997)—Obstruction of the transverse colon by adhesions.

were under 30, the youngest being 20.

The cancers were in the cecum in 71 cases; the ascending colon in 44; the hepatic flexure in 28; the transverse colon in 50; the splenic flexure in 23; the descending colon in 39, and the sigmoid in 104.

In 54 cases the cancer was described either by the surgeon or the pathologist as of the annular type. Seventeen of the ring cancers were in the sigmoid flexure, and 37 were in other parts of the colon.

Metastasis to the lymph nodes or to other organs, principally the liver, occurred in 140 cases; in these instances the primary growth was in the cecum in 34 cases; in the transverse colon in 25, and in the sigmoid flexure in 36. Stated otherwise, metastasis occurred in 48 per cent of the cecal cancers, 50 per cent of those in the transverse colon, 35 per cent of the sigmoid cancers, and 31 per cent of those situated elsewhere. These data substantiate Mayo's statement that the cancers of the transverse colon rank first for metastasis, and apparently the cecal cancers are not far behind in this respect.

Adhesions were present in 146 cases, 40 per cent of the total number. Intussusception was noted in but five cases.

Notwithstanding the gross percentage of adhesions and metastasis, resection was feasible and was performed in over two-thirds of the cases.

In 326 (90.8 per cent) of the 359 cases the roentgen ray furnished evidence, usually emphatic, that a lesion of the colon existed. In virtually all the positive cases there was either a filling defect or obstruction, and often both.

Obstruction to the enema was noted in 78 cases, while the findings recorded at operation mention obstruction in only 70. It seems probable that in the excess number the growth had a valve-like effect against the enema.

In examining the colon it is our general rule to report the roentgenologic findings as such and not attempt a diagnostic interpretation. However, in 51 cases the examiner ventured the opinion that cancer was present, and in a smaller number he was content to report "lesion" or "tumor" of the colon. The opinion as to cancer was, of course, merely a fortunate prediction; the more conservative diagnoses were quite justified.

In ten instances a diagnosis of "diverticulitis" was made; possibly cancer had developed on peridiverticulitis in some of these, but the fact was not proved by the pathologist save in one case.

No signs of a lesion were observed in 33 cases, 9.2 per cent of the total number, and these were reported as negative. Of the cases which were negative by the roentgen ray, ten were in the cecum (14 per cent of the cecal cancers), 11 were in the sigmoid (10.5 per cent) and 12 were elsewhere in the colon (6.4 per cent). It is at first surprising to find the greater proportion of failures to recognize lesions in the cecum for this region is accessible to inspection and manipulation. Yet it must be remembered that the normal cecum varies as to breadth and configuration, and judgment between the normal and abnormal must be cautious.

No negative finding was reported in the cancers of the hepatic flexure or the splenic flexure, but in one cancer of the splenic flexure the examiner was doubtful and reported the case as "indeterminate." Notwithstanding this fortunate showing, it is easy to understand that non-obstructive cancers of these flexures may be overlooked, because of the varying normal contours and the fusion of the angles.

Of the 54 ring cancers, only one evaded notice by means of the roentgen ray, and obviously this form of cancer should be easiest of all to find. But the opportunity for examination is not always given; during the period covered by this study 30 additional cases of annular cancer were sent to operation without investigation by the roentgen ray, and it is fair to assume that clinical signs of stenosis were so marked that examination by the roentgen ray was superfluous.

Outstanding Impressions Gained From This Study

1. More than 90 per cent of colonic cancers will show roentgenologic evidences of a lesion when examined with the opaque enema.

2. A diagnosis of cancer cannot be made on the roentgenologic findings alone, for the condition is simulated by various lesions, and especially by peridiverticulitis.

3. Cancers of the cecum are more likely to elude observation by the roentgen ray than those situated elsewhere in the colon.

4. Ring cancers are easiest to find with the roentgen ray.

5. The exclusion value of a negative finding should neither be overestimated nor underestimated. In some cases the roentgen ray will fail to disclose a lesion, but not more than one in ten cancers should escape detection.

6. Roentgenologic examination of the colon in cases of cancer will not throw light on the question of operability, since the growth may be resectable regardless of its location, extent, or the presence of adhesions.

Fig. 13—(Case A-258202)—Filling defect in the sigmoid in a case of salpingitis with adhesions.

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Multiple Peptic Ulcers*

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PEPTIC ULCER is properly considered to be a single lesion. It is only rarely that more than one ulcer occurs at the same time. However, two or more ulcers may be present simultaneously, and, judging from the literature, this takes place more frequently than is commonly supposed. The multiple ulcers may all be in the stomach or the duodenum or in both places.

In the days before the use of the x-ray, the diagnosis was made only in the operating room or dead house. Now, at times, the x-ray enables us to make such a diagnosis with accuracy before operation.

Rokitansky states that among his 79 ulcer cases at autopsy, no fewer than 17 presented two or more open ulcers. Brinton in an extensive study concluded that two or more ulcers are present in one out of every five ulcer cases. In other words, about 20 per cent of the cases are multiple. He reported 463 cases of ulcer and 97 of them had more than one.

In the Mayo Clinic, in a series of 638 cases of gastric ulcers, 28, or 4½ per cent had more than one present. Fenwick, in an exhaustive study of the postmortem records, analyzes 867 cases as follows:

One ulcer present in 698, or 80.5%
Two ulcers present in 105, or 12.1%
Three ulcers present in 27, or 3.1%
Four or more present in 37, or 4.2%

These are all cases with active or open ulcers. If the scars of healed ulcers are also counted, then the percentage would run much higher, for ulcers heal and recur at the same or other spots in the same region. It is not uncommon to meet in the same stomach open ulcers and the scars of healed ulcers. Numerous ulcers are usually of the acute type, but when two or three are present, they are most frequently of the chronic variety. Most of the cases diagnosed by the x-ray and found at operation are of the chronic type. The number simultaneously present rarely exceeds five. According to Fenwick, chronic gastric ulcer is multiple in 13 per cent of all cases, while acute ulcer is multiple in 50 per cent.

Bolton states that acute ulcers occur chiefly in three types of cases (1) acute infective processes, (2) chronic infective processes and (3) where there is no obvious infection.

In the first group all the ulcers are in an open condition and scars are rarely seen, while in the second group it is not uncommon to find partially healed ulcers and scars together with recent ulcers. Acute gastric ulcer tends to recur and commonly heals.

Brin reports a woman 38 years old with two large chronic gastric ulcers and a third small recent one.

A contrast to these figures of the surprising frequency of multiple ulcers is a more recent report by Goldschmid of a review of 1,300 autopsies in Frankfurt. In this number there were 25 gastric and 21 duodenal ulcers, but in no case was there more than one found.

In rare instances, the number of ulcers present in the stomach is excessive. Hewitt reports a case with 60 ulcers in the stomach. Berthold mentions one with 34 deep perforations in the stomach. Osler reports one with 34 ulcers in the stomach, and Lange described one in which the ulcers were too numerous to count. The mucosa in such cases is riddled with small ulcerations. Usually such cases are associated with septic infections or secondary syphilis.

Ulcer in the duodenum is usually solitary, but it, like gastric ulcer, may be multiple. Merot found a single duodenal ulcer in 82 per cent, two in 13.5 per cent, and three or more in 4.5 per cent. Carman, in 1917, reported that in the Mayo Clinic, during 1916, 139 cases of gastric ulcer and 490 cases of duodenal ulcer were operated upon. In 16 an ulcer was found both in the duodenum and the stomach. In other words, 11.5 per cent of patients having gastric ulcers had duodenal ulcers also.

The histopathology of multiple peptic ulcers resembles that of the usual findings of the single duodenal or gastric ulcers. In the chronic duodenal ulcer there is usually a superficial destruction of the mucosa with moderate involvement of the Brunner's gland. However, there is practically no destruction of the underlying muscularis and serosa. There may be a lymphocytic infiltration of the adjacent tissue and a moderate endarteritis. Changes in the ganglion cells have been noted by several writers.

The chronic gastric ulcers usually present a quite different, although characteristic picture. The mucosa ends abruptly in the region of the ulceration and the borders are sharp and perpendicular to the floor of the ulcer. There usually is an entire absence of the mucosa, submucosa and muscularis at the site of ulceration. The floor of the ulcer is formed by granulation tissue and thickened serosa. There may be a definite subacute inflammatory reaction in the adjacent tissue with an associated arteritis and involvement of the ganglion cells.

In the acute ulcers the involvement is usually limited to the mucosa. It is in this type that an acute perforation is more apt to occur.

Moynihan has called attention to the fact that perforating ulcers are at times multiple and he advises that as soon as the ulcer first discovered is sutured a rapid survey of the whole stomach is desirable in order that any other ulcers may be laid bare. In a majority, the second ulcer was found on the posterior surface at a point exactly opposite the first.

It is difficult to make a clinical diagnosis of more than one ulcer for the symptoms are quite similar. The x-ray often establishes the presence of more than one ulcer. It is sometimes difficult to demonstrate a duodenal ulcer in the presence of a gastric ulcer, for, in the presence of an excess of hydrochloric acid, the pylorus may show spasm and the pain of manipulation may prevent a proper filling of the duodenal bulb.

It is important in all x-ray studies for ulcer not to be satisfied with the finding of one, but to look carefully for another in the stomach and duodenum. Small ulcers are very difficult to detect and are often missed unless an especially careful search is made.

CASE NO. 1

Female, age 54, consulted us in April, 1920. She complained of eruc-

*—Read at the Annual Meeting of the Radiological Society of North America, Detroit, Dec. 6, 1922.

tations of acid, fluid vomiting, weakness and pain in upper abdomen.

The acute symptoms began eight weeks before and have grown steadily worse. At the outset she had eructations of a very acid fluid, and shortly afterward nausea and vomiting began. At first vomiting occurred one or two hours after taking food, but later even fluids caused distress. Later vomiting was more frequent.

Pain in the upper abdomen had been present the same length of time It was most frequently under the right costal margin and was referred to the back. The pain was sharp and gnawing. It was at first relieved by food and alkalies, but later only vomiting brought relief. Weakness and loss of weight became progressively worse. Constipation was present. The past history contained nothing of importance to the present trouble except that she had heart burn and eructations at intervals for years preceding the present trouble. There was no history of jaundice. The family history does not contain anything of note.

The physical examination revealed no abnormal findings in the nervous system. The pupils reacted to light and accommodation. The tonsils were small and ragged. The heart and lungs were normal. The abdominal wall was thin and flaccid. The liver was slightly enlarged and firmer than normal. There was some tenderness over the gall-bladder, but it was most marked over the epigastrium and here the abdominal wall was rigid on palpation.

The blood showed 3,600,000 red cells, 9,000 white cells, and the hemoglobin was 75. The Wassermann test was negative. The urine was negative. The stool showed occult blood. The stomach test showed free HCL 15, total acidity 35. The test for occult blood gave a marked reaction and sarcinae were present in large numbers.

The x-ray study made by Dr. Jenkinson did not show any evidence of gall stones. The stomach was large and dilated. There were two penetrating ulcers in the lesser curvature, involving the pars media (Fig. 1). The pars pylorica was irregular and could not be filled. The duodenal bulb was normal. The emptying time was markedly delayed. At the end of 24 hours the stomach was more than half full.

At the operation, which was done by Dr. McArthur, the two penetrating ulcers were found, and these were resected and the stomach anastomosed to the jejunum. The gall-bladder was found full of stones and the entire gall-bladder was removed.

The patient made a good recovery.

Fig. 1

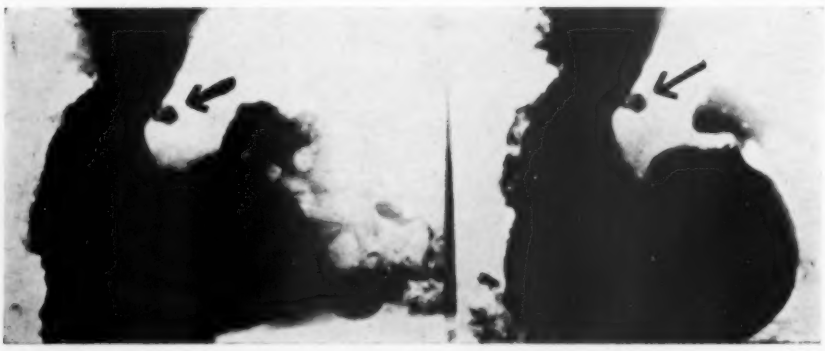

Fig. 2

Case No. 2

Female, age 43, was referred for consultation by Dr. Getty in 1920, and it is through his kindness that we are making this report.

She complained of epigastric pain at times, relieved by food and alkalies. There was no nausea. Tenderness was present in the epigastrium. The stomach contents showed 28 free acid and 38 total acidity. The x-ray showed deformity of the duodenal bulb. She was given medical treatment for ulcer by Dr. Getty and left the hospital feeling well. Three months later the symptoms returned, and the x-ray showed a similar duodenal bulb deformity and an irregularity of the lesser curvature of the stomach (Fig. 2). A little later hematemesis occurred.

She was operated by Dr. McArthur. An ulcer located on the upper third of the lesser curvature was resected. A gastro-enterostomy was not done.

Two months later all the symptoms returned with greater severity. Medical treatment was tried again without avail and she consented to another operation by Dr. McArthur. A posterior gastro-enterostomy was done. She remained well for six months and then symptoms returned and she began passing tarry stools, and a few weeks later vomited blood, and this was repeated and five transfusions were necessary.

Another x-ray study showed an ulcer on the lesser curvature with spastic indrawing of the greater curvature opposite, and deformity of the bulb and pylorus. There was marked delay in the emptying time. Dr. Richter did an anterior gastro-enterostomy, but the patient has not been entirely comfortable since that time.

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The Relation of Roentgenology to Urology*

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"LET YOUR LIGHT so shine" —I feel that mine, midst the highest powered illuminators and deepest penetrators of this country, shall glimmer as a mere candle. Portia, though she said that "the greater glory doth dim the less" also said, "How far that little candle throws its beams; so shines a good deed in a naughty world." So, perhaps, some ray of light may be emitted in my discussion of the mutual relationship of roentgenology to urology.

Let me preface my remarks further by stating definitely that I make no pretence of familiarity with the intricate mechanics of radiography, but from my intimate association with this branch of medicine over a period of fifteen years I feel that I am at least fairly competent in the interpretation of its results as applied to my special line.

In the very beginning of my practice I was closely affiliated with your president-elect, Dr. Carman, and through daily contact with him I began early to see the enormous benefit to be derived from the close association of these two branches of medical effort. Under his tutelege I gained much valuable information which has been greatly augmented during the recent years by intimate relationship with Dr. Ernst and Dr. Sherwood Moore.

Throughout the development of urological surgery there has been one feature permanently prominent, that is that accurate diagnosis is the fundamental factor for properly directed surgery. Such a diagnosis is impossible unless there be this co-relation between roentgenology and urology. Their dependency upon each other is so vital that I feel that no one is equipped to do accurate scientific urological investigation without this alliance. This means not neighborhood proximity, but an absolutely direct proximity. One must either adjoin an x-ray expert or have a trained technician of his own and be capable himself of personally interpreting the results of the radiological examination.

For this reason, I installed an apparatus of my own, and I have been so remarkably impressed with its great value that I would feel materially handicapped without it. There is scarcely an urological investigation, no matter what may be the nature of the condition, that does not require roentgenological aid.

Urology is the father of surgery. In pre-historic times, urological operations were performed, but were crude in character and usually unfortunate in results. The first authentic operation was done by Celsus, centuries ago. Throughout a long period of years until the middle of the nineteenth century, operations upon the urinary organs were exceedingly rare and were always exploratory, owing to the lack of facilities for scientific study, and not until the middle of 1861 did Walcott operate for renal tumor. The first lumbar nephrectomy was done by Simon of Heidelberg, in 1869. It is interesting to note that the first operation on the urinary organs was for calculus. It is for this particular condition that we owe your important branch of medicine an everlasting debt.

In the early part of the nineteenth century, we find Bozzini presenting an endoscopic tube through which he reflected light into the bladder as a means of diagnosing diseases of this organ. His instrument and theories were not accepted until 1853, when Desormaux was able to convince the professional world of the actual results of such an instrument. Very little was done, however, until Nitze in 1877 presented his lens cystoscope with a lightning attachment; modifications were made, and in 1886, with the addition of incandescent lamps, the cystoscope became the creator of this branch of medicine. Our profession owes a great deal to this genius for his marvelous discovery.

Many men presented modifications of this instrument, and improvements were gradually made by Brenner, Leiter, Tilden Brown, Lewis, Buerger, Casper, Allbarran and others, until these instruments finally reached their acme of perfection about the year 1910. Since then the cystoscope with a proper interpreter gives the most accurate estimation of the interior of the bladder and allows a comforting surety of an exact diagnosis of its many pathological conditions. But that is not all. With only the cystoscope, the largest field of urology, namely the upper urinary tract, would be in a phase of bewilderment. This has been obviated by Simon's discovery that the ureters were possible of catheterization. His important discovery, while impractical and crude, because it was done blindly and with such attendant danger, stimulated Kelly and Pawlik to the scientific investigation of the upper urinary tract through the ureter catheter by means of the cystoscope. This was first done with a hollow tube, by reflected light, in the cystoscopy of a female patient in 1888. At first the difficulties were naturally pronounced, but with modern instruments this process has been so simplified that it requires but a few seconds or minutes for its performance.

Diagnosis improved with the development of these cystoscopic instruments, and surgery of the urinary organs became more and more frequent, yet the knowledge of diseases of the upper urinary tract was still clouded with confusion. Then came the bright light on the horizon of urology, when the wonderful discovery of Roentgen met its first application to this branch of medicine. As far as I am able to determine, the first authentic radiographic application to renal surgery was made by McIntyre of Glasgow, in July, 1896, by means of a roentgenogram obtained with a six inch spark and a twelve minute exposure. There was recorded an elongated shadow in the kidney, which was diagnosed as stone, and Adams of Glasgow operated and removed it.

Other observers, among them Swaine, late in 1896, Loewenstein and Fenwick in 1898, Bruce about the

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same time, and Bevan, McArthur and Leonard became interested in roentgenology.

Fenwick, in 1897, was the first to successfully take a radiogram showing the outline of the kidney. In a radiogram of a kidney stone, he remarks that there is a perfect outline of the kidney shadow. This led to the greatest advancement in urology since the discovery of the cystoscope. Fenwick was also the first to fluoroscope an exposed kidney for the detection of calculus, a method which has been put into practical application by the Mayo Clinic and one so extremely important that it should be routinely employed in all cases of upper tract calculi.

It was soon found that these two methods of investigation when utilized individually were unsatisfactory, for neither one alone sufficed to establish an accurate diagnosis. As early as 1897, one finds Tuffier passing an opaque catheter up the ureter and simultaneously taking an x-ray picture. In 1901 Schmidt and Kolischer independently published radiograms showing the position of the ureter and the situation of the renal pelvis. This was followed by reports from Loewenhardt and Von Illyes. It was in 1905 that Fenwick suggested the use of the ureteral bougie with its walls impregnated with metal. This simultaneous application was an advancement in the localization of urinary calculi, but very shortly it was found that this was not adequate and Klose suggested the injection of bismuth into the ureter and pelvis of the kidney with simultaneous radiography. This method failed because the shadow was uncertain and the bismuth difficult to remove, but its principle was correct and stimulated one of the notable advances in urology, namely, pyelo-ureterography. Voelker and Lichtenberg in 1906, by means of collargol injections perfected this method. From this time on, the simultaneous application of ureteropelvic filling combined with radiography has passed through many hands until it is now as accurate a method of diagnosis as exists in any branch of medicine.

I shall briefly mention, by way of history, some of the contributors to this procedure, which at the present time finds a universal application.

Keyes in 1909 suggested argyrol, Uhle and Pfahler suggested electrogol. Burkhard and Plano in 1907 first suggested the injection of oxygen into the pelvis. Lichtenberg, Dietlen and Cole also commended its use. The gaseous medium did not meet with widespread acceptance, and later in 1913 we find that Uhle, Pfahler, Kelly and Lewis suggested silver iodide emulsion. While these methods were of diagnostic value, they were not without untoward effects and several deaths from emboli and occasional severe renal reactions followed. For this reason, therefore, Burns presented thorium nitrate, which has been used for a number of years because of its more acceptable qualities, in that it does not stain, is not irritating and does not cause the disagreeable features of the silver salts. Recently sodium bromide has supplanted the other media and is almost universally used. It is non-irritating, casts an excellent shadow and is inexpensive. Pyelography has been popularized and put on a substantial basis by the untiring efforts of Braash, to whom the greatest credit should be given for this phase of diagnosis. In repeated articles on this subject, he has given diagnostic data of most of the diseases of the kidney and ureter.

I shall not take your time to discuss the method or procedure, except to say that I am thoroughly convinced in my own mind that the syringe method with rubber bulb is the safest, in that steady pressure can be made, accurate filling accomplished and immediate aspiration done in case of pain. I, personally, see no advantage to the gravity method. Pyelography, of course, is not without dangers; but with careful technique troublesome complications should be extremely rare. The media should be non-toxic and non-irritating and should be thoroughly sterilized. There should be gradual, steady filling with the ability to aspirate, and regulation of pressure with the cone, which should always be placed before the pelvis is filled. One must refrain from this procedure if there are contra-indications, such as fresh hemorrhages, infected retentions, severe vascular diseases and renal insufficienties. Let me particularly call your attention to the inadvisability of giving sedatives preceding pyelography, since they may mask sensation and create a tendency to overfilling.

Gradual development has brought our two specialties more and more closely together, until at the present time they may well be called the Siamese Twins of Urology. In practically every disease of the kidney and ureter, and in a great many diseases of the bladder and prostate, the use of x-ray is indicated.

From a clinical standpoint, it should be applied to the five cardinal signals of urinary disease, viz: in every case of abdominal pain or pain in the back; all cases of blood or pus in the urine which are not of venereal origin; all cases of bladder irritability not definitely ascribed to gross lower tract obstructions, and in every indefinite abdominal mass.

X-ray finds its most valuable field in urinary lithiasis and without it an exact diagnosis cannot be made in the upper tract. Diagnoses can be made with it which are unattainable in any other way, for instance, when cystoscopy is impossible. Through it a tentative urological diagnosis can be confirmed or denied. This is its most valuable field, since here the greatest degree of accuracy is obtained when it is simultaneously employed with urological methods of investigation, namely, ureteropyelography and cystography. If habitually employed, many unsuspected discoveries may be made.

Method of Procedure

In any of these five indications, my routine is about as follows: After a cystoscopic study of the bladder, catheters are passed into the ureters, though occasionally conditions found in the bladder make this unnecessary. While the specimen is being secured from each kidney and the function is being determined, a complete radiographic series is taken of the kidneys, ureters and bladder. One should never short cut by taking one kidney or both kidneys, but since symptoms may be deceptive, and furthermore, since there is so frequently an associated bilateral lesion, the whole tract must be observed, as was first called to attention by Contremoulens in 1907. Various preparatory methods have been advocated, consisting chiefly of thorough cathartics and restriction of certain foods, but from my personal experiences, particularly with routine ambulatory cases, the less the intestinal churning with cathartics, the better the plates.

It has been my custom to take a three plate series, one for each kidney, one for the lower ureters and the bladder. It is seldom necessary for a five plate series, at least on the first study. The one large plate technique has not given satisfactory details in my experience and the simultaneous radiography of the two kidneys is not as a rule satisfactory, since it misses the chief essential in renal picturing, namely, extreme fixation.

The plates are immediately developed, and if they are not perfect, or if there are suggestive findings, they are retaken. I do not consider a perfect plate one that shows the psoas muscle, the last ribs and the spine, but one which shows the kidney in its entire outline, as has been suggested by Dr. Carman.

Following this, depending, of course, upon what has been found in the specimens and in the function, either a unilateral or bilateral pyelogram is made. Bilateral pyelography has met adverse discussion, but under very careful control it seldom causes any trouble, provided the ureter catheter is left in place where immediate aspiration may be

done if necessary. I never fill both kidneys simultaneously, but individually.

The suspiciously diseased or definitely diseased side is filled first and if there are no contra-indications, the supposed normal side is done very carefully. In case of ureteropyelograms where one is dealing with hydronephrosis (which, of course, has been previously detected by the insertion of the catheter into the pelvis with determination of retention), bilateral pyeloureterogram is a more serious problem and should seldom be done at the same sitting.

In large hydronephroses, it is essential that the pelvis be thoroughly drained before pyelography, since many of the poor plates in such instances are due to dilution of the media with the products of renal retention.

Pyelograms are then developed, and, if satisfactory, the patient is drained and given a pelvic antiseptic injection and allowed to go. If the plate is not satisfactory, there is a retake, unless there be contra-indications, but these are seldom. I use 15 per cent sodium bromide.

The interpretation of pyelograms is extremely important and requires considerable experience. The typical hydronephrosis, pyelonephritis or renal tumor needs no particular keenness of perception, but the frequent variations found in pelves showing filling defects and distortions need the most careful scrutiny. Here we must never forget that we are dealing with a surrounding muscle which is physiologically possessed with the power of contractibility and susceptible of spasm, which is capable of producing such changes without underlying pathology. The release of spasm, either spontaneously or with atrophin, will upon a check filling, often reveal a normal outline. Such pelves are frequently interpreted to have tuberculosis, tumor and the like, and it is only with repeated study and correlation with urological findings that the exact diagnosis is possible.

By this method, the exact location of renal and ureteral shadows can be determined and the differentiation of urinary from extra-urinary shadows can be made. In certain cases, of course, particularly the lower pelvic shadows, either stereoscopic ureterograms or the simultaneous snapping of two pictures on the same plate at a different angle, as called attention to by Kretschmer, may be necessary.

If there are evidences of hydronephrosis a picture taken in the prone and upright position should always be done to determine the degree of renal movability and torsion, and the presence of ureteral kinks, twists and strictures.

Innumerable instances could be cited of the remarkable value of this close affiliation of the x-ray and the ureteral catheter. Two recent impressive lessons will serve as illustrations.

Two individuals presented themselves who had been treated for pyelitis by innumerable pelvic lavages for many months without improvement, both had had repeated x-ray plates with negative findings. Our x-ray pictures taken with catheters in place showed in both instances that the catheters curled up in the ureter and an ureterogram showed that the ureters in both were enormously dilated, due to obstruction at the ureterovesical valve. They were both cured by incision of the ureterovesical valve with the relief of the obstruction, one by means of the operating cystoscope and the other by a new operation which I have just described for intravesical transposition of the ureteral orifice.

Let us then discuss some features of the x-ray as applied to the study of the five essential points previously described.

Every case of abdominal pain should be rayed, unless it shows itself very definitely to be an acute abdominal condition needing immediate surgery. In a rather large series of kidney cases which we studied several years ago, 27 per cent of renal and ureteral stones had had previous appendectomies without relief—an x-ray could have saved this misdirected surgery, since the x-ray is capable of showing the great majority of ureteral and renal calculi. The diagnostician should less habitually frequent the smooth pavement lining of the peritoneal highway and direct his meanderings more often to the stony gutters in the rear.

There are, however, several warnings. It has been variously estimated that two to five per cent of cases are shadowless. I believe, with thorough study, good plates, and repeated plates, that the figures should not exceed two per cent.

It is in this particular type of case that the roentgenologist must be extremely guarded. I feel that the expression, "The x-rays are negative," should not be used. I will explain my meaning. A physician sends to the roentgenologist a patient with a history suspicious of stone, the patient suffering with what seems to be renal colic. X-rays are taken, the plates show no evidence of stone and the roentgenologist reports that the x-rays are negative. This conveys to the practitioner's mind the fact that the kidneys are not the cause of the pain. I have seen this many times. The roentgenologist should say that the x-ray *shows no definite evidence* of renal or ureteral stone. In this way, the mind is not diverted from the kidney. So many kidney and ureteral conditions may be responsible for the same type and character of pain as is imposed by stone, and yet they may cast no radiological evidences of disease. The most important of these conditions are hydronephrosis from kinks and renal movability and from aberrant vessels, stricture of the ureter, hydroureter from obstruction at the ureterovesical valve, hydro-ureter from regurgitation from the bladder, due to a patient ureterovesical orifice, srystal showers, shadowless calculi and central nerve crises. It is only by the use of the x-rays with urology that these conditions can be determined.

It may surprise you also to know that in a fair series of cases, on which renal fixation was done for the relief of pain due to such causes, 30 per cent had had previous appendectomies and 10 per cent previous gall-bladder operations without relief. This is the most insidious type of kidney pain because of its negative urinary and radiological findings. We are learning more and more that vague renal pains are due to obstructions in the lower ureter, hence the great importance of ureterograms.

We must also be cautious in the case of what seems to be typical renal pain associated with a few red blood cells in the urine, with negative x-ray findings for calculus and definite ureteropyelographic evidences of either tortuosity or kinks of the ureter with or without hydronephrosis and ostensible indications for renal fixation. Such conditions, however, rarely cause scattered blood cells in the urine; if bleeding occurs, it is profuse. In my experience such a symptom complex has always been relieved by the passage of a small shadowless calculus.

It should furthermore be definitely understood that no one should ever operate for calculus of the upper urinary tract upon x-ray findings alone. I have seen many instances of shadows, seemingly typically renal, which proved by thorough examination to be either gall stone, gland, enterolith, calcification of a tuberculous focus or calcification in a renal tumor.

To illustrate how important it is to be ultra careful,—a woman appeared with an x-ray plate which showed a round shadow in the right kidney region, dense and white, giving every evidence of a renal calculus. She had consulted her doctor on account of profuse hematuria and pain in the right upper quadrant. She had been given the diagnosis of right renal stone and was told to have the kidney explored. When she came to me, I found her bleeding from the other kidney. The kidney in which the shadow seemed to be was entirely negative, pyelogram was

normal, the shadow was movable and proved to be a gall stone.

In case there is a definite coral, branched stone, where the chance of diagnostic error is negligible, urological study must be done in order to determine the function of the kidney and more particularly that of its mate, in order that proper surgery may be executed.

In ureteral shadows, the condition is even more complicated and no suspicious ureteral shadow should ever be surgically sought until it has been definitely studied by combined radiography and cystoscopy. The old idea that the ureteral stone operations were extremely difficult was due to the fact that the stone was not present. When the stone is there the operation is usually simple.

There are certain classical zones of election for stones, pheboliths and glands, but atypical shadows occupying the border line positions defy exact diagnosis in the hands of the most expert roentgenologist.

The x-ray is assuming a valuable place in tuberculosis of the urinary tract. It frequently shows areas of calcification in the kidney and occasionally a complete calcification of the organ as brought out by Colston and others. I have had six such extreme cases. Rarely it shows the outline of the ureter. In one case, a young girl, the x-ray showed a complete outline of the kidney and ureter, the ureter being as big as the finger. The patient had been treated for hip disease, owing to contracture of the psoas muscle, due to implication of the ureter. Nephroureterectomy cured the limp.

Coupled with pyelography, advanced tuberculosis gives a definite picture not seen in any other lesion, namely, fringy irregularities of the pelvic and ureteral outline. In early lesions, there may be polar aberrations, filling defects and salyx constrictions, which with urinary findings, establish the diagnosis.

Such findings are frequently encountered in cases of bladder irritability.

Abdominal masses are definite indications for roentgenological study. The x-ray will occasionally show calcifications in a renal tumor or enlargement of the kidney. With pyelography, one can almost invariably say whether a mass is or is not renal. One has to be particularly careful in interpreting the size of a kidney by means of x-ray pictures. I have been personally deceived in many instances. My first attention was called to this in the case of a floating kidney, the shadow of which was extremely large on several x-ray plates. At operation the kidney was really smaller than normal, but encased in a large amount of perirenal fat. The mere fact of extreme deflection of the ureter catheter either inwardly or outwardly is not indication of an extra-abdominal tumor. I have seen such deflections from large gallbladders and bowel growths.

In congenital lesions of the kidneys and ureters, it is only with the combined employment of our two paraphenalia that we can arrive at a satisfactory diagnosis.

I shall spare your time in discussing anomalies, except to say that they are frequent findings and now occupy an important chapter in urology, since we have investigated them together. A few words might not be amiss in discussing the importance of systematic combined study, in the detection of the ectopic kidney.

Of three cases which I have encountered in the last few years, two presented lower abdominal masses associated with abdominal pain and evidences of infection, both were diagnosed appendiceal abscess, both had pyuria. Cystoscopic examination showed pyonephrosis in both instances with low function on the corresponding side.

The catheters went to a normal distance without any appreciation of obstruction and no suggestion that the kidney was in an abnormal position. Both gave indications for nephrectomy and had not the combined study been made a lumbar exploration would have failed to show the kidney. In both instances the catheter curled up in front of the promontory of the sacrum, such a position demanding a lower abdominal incision.

The other case was a unilateral fused ectopic kidney which required suspension. The value of roentgenology in diseases of the bladder is much more limited than in diseases of the upper urinary tract. It plays chiefly a cooperative role and except for cases which do not permit cystoscopy, and they are extremely rare, and in stones incarcerated in diverticuli, it possesses doubtful value when used alone. The cystoscope is so much more certain in the diagnosis of vesical calculus, since it not only visualizes the stone, but allows proper interpretation of associated vesical conditions.

One must know the type of vesical orifice as well as the presence of the stone and whether or not there are sacculations, diverticuli or tumors of the bladder. About 50 per cent of the stones may be crushed, provided they are not back of gross obstructions. The small obstructions may be removed by endovesical operations after litholapaxy, but in the gross obstructions, the stone forms an integral part of the operation for obstruction.

Cystography, however, has a valuable field in that it will show the shape, size and position of the bladder and changes in its contour, particularly at its internal orifice. Its most valuable field of application is in the bladder diverticulum, whereby the exact size and relation can be determined, as by no other method. It furthermore gives valuable information in carcinoma of the bladder in showing filling defects and indentures, particularly at the internal orifice. Often cystoscopically it is impossible to definitely determine the amount of orifice involvement. If such defects are detected, it is a pretty safe indication that partial resection is out of the question.

In the neurogenic bladder, there is often a definite funneling at the internal orifice. It provides another diagnostic service in this type of bladder in detecting spinal column defects such as are seen in spina bifida occulta and offers an occasional explanation for the incontinent bladder of children.

Regurgitation from the bladder up the ureter due to inability of the ureterovesical orifice to coapt has been illuminated by this method. Through it we have learned to explain many of the ascending kidney infections. Through it we have also learned to appreciate the importance of congenital valve obstructions and contractures at the internal vesical orifice, which were otherwise indefinite.

In the prostate, as in the kidney, the x-ray serves its most important mission in the detection of stone. Prostatic stones are usually discernible by radiographic means and such stones need recognition, since they are frequently the cause of chronic infections in this organ. They are usually multiple and small, but occasionally quite large. I removed one about a year ago, the size of a large walnut. Successful prostatic picturing depends greatly upon technique, owing to its anatomical position in the anterior segment and directly behind the symphysis an anteroposterior plate is seldom satisfactory. The oblique posteroanterior position is necessary. The plate is placed under the genitals and the cone obliquely posed upward against the coccyx, in this way the shadows within the prostate are deflected above the symphysis and not obscured by it.

If the x-ray shows a definite shadow of the whole prostate, one should always be suspicious of carcinoma. I have seen it in several cases of cancer of the prostate, but do not recall having seen it in any other condition.

One frequently encounters difficulty in differentiating the cause of backache; chronic infections of the prostate and vesicles are very often responsible, but one can never be certain, unless protected by a picture of the sacro-iliac joint and lower spine.

Even in rare penile lesions the x-ray is of service, particularly in Pyronnes' disease or induration of the shaft it enables us to determine the presence of calcification.

Aside from its superb diagnostic qualities, which have aided so much in the advancement of urology that our debt can never be paid, the x-ray is assuming an important function as a therapeutic agent in the palliation and in certain cases the cure of malignant tumors of the genitourinary tract.

I shall speak but very briefly on this phase of the subject, as I am not thoroughly convinced in my own mind of its real value. I am however confident of curing an enormous extrarenal gland metastasis, following a nephrectomy for cancer of the kidney which I did five years ago. The mass surrounding the deep vessels was as large as a big orange. A section of this mass showed cancer. Deep therapy given by Dr. Ernst with a machine not nearly so effective as those of the present day, caused the most marvelous melting of this mass. The patient is living and well. I have seen another inoperable with resulting improvement of symptoms.
tumor of the kidney reduced in size

In cancer of the bladder, I have seen excellent palliative results, but when used alone, no ultimate benefit. Associated with resections and along with endovesical high frequency application I have used it routinely.

I am positive that an operable tumor should always be removed and furthermore the more experience the surgeon has had, the more often tumors are found operable. One should never, in my opinion, offer in such cases, either x-ray or radium as a substitute for surgery, but only as an adjunct.

In prostatic cancer with periprostatic involvement associated with severe pains in the hip and legs, almost invariably there has been, after the second application, almost complete cessation of pain. I have noticed the tumor mass soften materially and urinary obstructive symptoms decidedly quiesce, but these results have unfortunately been evanescent. The condition has usually returned.

In the early lesions, well localized clinically, the x-ray or radium or both should be given a trial and the patient's condition carefully observed.

In prostatic cancer, there are two chief problems, the first the cure of the cancer and the second the handling of the often associated urinary obstructions. If the process is limited and obstruction is minor, the x-ray or radium or both may be all that is necessary. If the tumor is larger and responds to deep therapy, the obstruction may often be relieved, by the cautery punch operation.

In gross obstructions surgical removal is required and my best results in prostatic cancer have been the ones in which perineal prostatectomy had been done with implantation of radium into the capsule, followed by deep x-ray therapy.

I am extremely interested in this type of therapy and am very fortunate to be associated with Dr. Sherwood Moore and Dr. Ernst who has advised or conducted most of these treatments.

In conclusion it is fitting that I pay a tribute to roentgenology as the inseparable handmaiden of urological diagnosis and therapy. The human eye, though aided by the most ingenious devices of a mastercraft must still be limited in its range of vision, but the x-ray, like something divine, has power in a search for disease and its symptoms to penetrate the innermost recesses of our earthly structures, to lay all secrets bare and leave little to be disclosed for scientific investigation.

723 University Club Bldg.

X-Rays and X-Ray Apparatus; An Elementary Course*

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CHAPTER II.—(Continued)

THE MERCURY BREAK INTERRUPTER

36. For small coils, or those on which heavy demands are not to be made, the hammer break is fairly satisfactory. With coils which are to be used for heavy radiographic work, the hammer break is of little use. The excessive sparking, accompanied by disintegration of the contact points, makes such a break very unsatisfactory. Large coils, therefore, are operated by using either a mercury or an electrolytic interrupter. The principle utilized in the construction of the former of these will be clear from the following brief description of one type in common use. By means of a motor (Fig. 35, a, top view; b, side view) a vessel V whose lower portion dips in mercury can be rapidly rotated. As a result of the rotation mercury rises until it is forced out of the tubes J_1 and J_2 at the top of the vessel. If the tubes are in the position shown in Figure 35b, the jets of mercury on leaving the tubes strike two metal pieces A and B which take the place of the contact points of the hammer break. In other words, the interrupter is placed directly in the primary circuit and current can only flow when there is electrical connection between A and B. This will be the case when the jets are anywhere between positions I and II of Figure 35b. As soon, however, as the vessel has rotated past position I, contact is broken. As V rotates, therefore, the current is regularly interrupted, the number of interruptions depending on the speed at which the motor is rotated. The rotating vessel, together with the contact pieces A and B and the supply of mercury are all enclosed in a containing vessel in which the air is replaced either by a liquid dielectric such as paraffin or by ordinary illuminating gas from the supply mains. In the latter case care must be exercised that no air is left in the apparatus, otherwise an explosion may occur.

From the nature of this break, it should be clear that the frequency (the number of makes and breaks per second) may be varied over a wide range by simply regulating the speed of the motor. Frequencies as high as 200 per second may be obtained. By way of comparison it may be stated that although in the case of the hammer break, the frequency may also reach this maximum value, it is often as low as 25 or 30 per second.

THE WEHNELT ELECTROLYTIC INTERRUPTER

37. To utilize this type of interrupter, a vessel containing a 20 per cent solution of dilute H_2SO_4 (specific gravity 1.2) is inserted in the primary circuit. The positive electrode (the anode) is a platinum point P (Fig. 36), the negative electrode (the cathode), a large lead plate L. (Note also Fig. 37.) With such a device, when the primary circuit is closed in the usual way, the current is regularly and rapidly interrupted at the platinum point, provided current conditions are within certain limits. The amperage, for example, should not be much below 10 nor much above 40 amperes, while with voltages across the terminals exceeding 80 to 120 the interrupter will not work. Potential differences of the order of 60 volts are normal.

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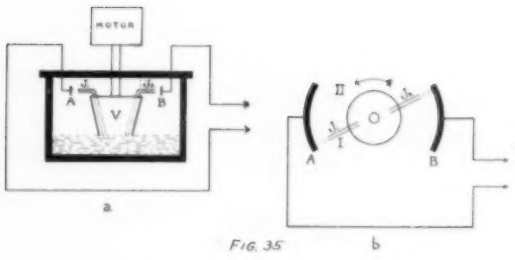


FIG. 35

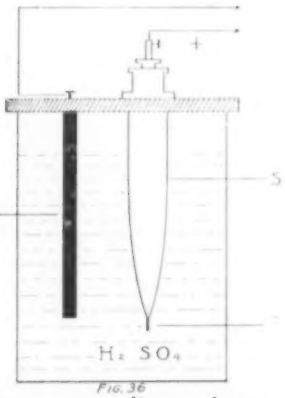


FIG. 36

It is difficult to state with certainty the exact nature of the action of this type of interrupter. It is somewhat as follows: When the current begins to flow, the formation of gas bubbles about the platinum point introduces an insulating layer which soon breaks the circuit; the E.M.F. of inductance causes a spark to jump the gap, thus exploding the gases and closing the circuit once more. In some such way a periodic opening and closing of the circuit takes place. But the action is complicated, the frequency depending on the amount of inductance and of capacity in the circuit, the temperature and the concentration of the acid, and the size of the platinum point. By means of an insulating sheath S, the extent to which the platinum point is exposed to the acid can be altered and in this way the interrupter regulated. Values of the frequency as high as 1500 or 2000 per second may be obtained, while even with heavy currents the frequency may not go below 200 per second. "With a suitable current the anode is normally surrounded by a violet light, and the interruptions are of an explosive and almost deafening character" (Kaye). Silencers, however, are now added, thus eliminating to some extent the latter undesirable feature.

The electrolytic interrupter has the advantage that no condenser is necessary, but the disadvantage that considerable inverse is present.

Suppression of Inverse or Reverse Current

38. As already noted it is highly undesirable to have any reverse current passing through an x-ray bulb. The reasons for this will be more apparent later; here we may simply state that inverse current (1) gives rise to x-rays from parts of a tube other than the target; (2) increases the possibility of a tube puncture and, apart from puncture, shortens its useful life; (3) gives rise to erroneous and consequently misleading readings of the milliamperage in the tube circuit. (Regarding (3) it should be evident, that, since milliampere-meters are *direct* current insctruments, the presence of a reverse current will make the reading on the instrument less than that corresponding to the current passing in the right direction.) When, therefore, coils are used as the source of high potential, certain rectifying means are used to suppress any inverse which may be present. A brief reference will be made to a few of these:

(1) *The Spark Gap.*—Any kind of spark gap inserted in series with the x-ray tube, as in Figure 38, is effective, provided the voltage necessary to cause a spark to jump the gap has about the same magnitude as the inverse. Obviously a voltage less than that corresponding to the spark length can cause no current in the tube circuit. This method entails a considerable loss of energy, and would be useless for cases where the magnitude of the inverse voltage approached that of the direct.

(2) *The Point-Plane Gap.*—An improvement of method (1) consists in using a point-plane spark gap. This is more effective because a discharge crosses such a gap more readily when the point is positive than when it is negative. Such a gap, therefore, should be connected in series, just as in Figure 38, care being taken that, for the current in the right direction, the point is joined to the negative terminal (the cathode) of the tube.

(3) *Valve Tubes—Old Type.*—Perhaps the rectifier most frequently used with coils is the valve tube. The older type consists essentially of a vessel (Fig. 39) from which the air has been *partially* removed, and which contains two electrodes, one, A, enclosed in a side arm, the other, B, extending into the central part of the valve tube so that, unlike the first, it is quite *unrestricted*. The efficiency of this kind of valve depends on the fact that, with the gas pressure in the vessel within proper limits, a restricted electrode will function practically only as an anode (i. e. a positive terminal). Such a valve, therefore, is placed in series with the x-ray bulb, again, just as in Figure 38, care being exercised that the restricted electrode is joined to the negative terminal of the tube.

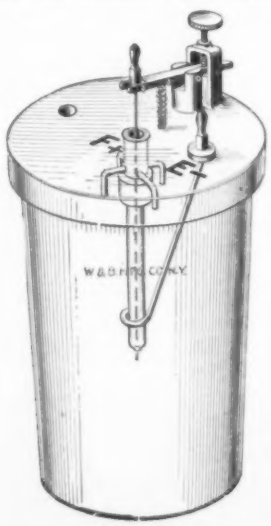


Fig. 37

(4) *Valve Tube—New Type.—The Kenotron.*—A much more satisfactory type is found in the *Kenotron*, a detailed description of which will be given in connection with the Coolidge tube. Here we may note that the principle utilized is exactly the same as that underlying the valves used so extensively in "radio" work.

(5) Other mechanical rectifiers have been used in connection with induction coils, at least one of which differs little in principle from the rectifier utilized in the interrupterless transformer. Little would be gained, however, by extending our discussion on this subject.

The Coil Versus the Transformer

39. Although the coil for heavy x-ray work is used so little in the United States and Canada that one can with difficulty find it mentioned in advertising literature, it should not be overlooked that in England the coil is by no means obsolete. In the recently (November, 1922) opened x-ray department of the Manchester Royal Infirmary, for example, coils have been retained in the treatment room, although high tension transformers form the major portion of this part of the equipment. Moreover, in the extensive volume on radiography by Knox (Vol. I, 1917), radiographs are shown which indicate, if anything, superior work in the case of the coil. Further evidence that much is to be said for the coil is found in the report in the *Electrician* (March, 1920) of a discussion on this whole question by eminent English radiologists, in conjunction with electrical engineers. It must be remembered that the coil generates a high voltage which attains to its maximum value and drops to zero in a small fraction of the time between successive breaks, whereas in the case of the transformer, the high voltage is applied for often a considerable fraction of a half-cycle, that is, for a considerable fraction of the total time between successive impulses. This gives the coil an advantage within the

limits of its capacity. But, for heavy work, the advantages are all in favour of the transformer, while the freedom from interrupter troubles is a tremendous gain.

Chapter III.
The Origin of X-Rays

40. In the gas bulb a current passes through the rarefied gas in the bulb; in the Coolidge tube, a current passes, although the vacuum is as perfect as modern means of exhaustion can make it. Before the action of either can be understood, it is necessary to consider somewhat in detail the whole question of the passage of electricity through a gas. At the outset, it is well to recall certain fundamental electrical ideas.

Any two bodies when rubbed together (so that their surfaces may come into close contact) become electrified, one positively, the other negatively. By positive, we mean simply a charge of electricity similar to that on a glass rod which has been rubbed on silk; by negative, a charge similar to that on an ebonite rod rubbed on fur, or to that on a piece of sealing wax rubbed on wool.

A body with a positive charge repels a second body similarly charged, but attracts a negatively charged one.

To study many things in connection with electrified bodies, one frequently uses the *gold leaf electroscope*. In a simple but useful form, this consists of a metal rod AB (Figure 40) *insulated* from the supporting vessel, attached to which is a piece of light metallic leaf CD (*gold* leaf is not necessary). If the rod and leaf are given an electric charge, either positive or negative, the leaf is deflected an amount proportional to the charge on the insulated system.

Ionization of a Gas

41. Suppose an electroscope, made with the most perfect insulation possible, is given a charge. If the deflection of the leaf is observed hour after hour, it will be found that, although there is an extremely slight falling of the leaf, the charge is retained even for days. We conclude, therefore, that while air is not a *perfect* insulator, at any rate it is an extremely poor conductor of electricity. (Evidence that air is not a perfect insulator has been given implicitly when it was pointed out that, once the voltage across two conductors exceeds a certain value, a spark jumps the gap between them.)

It is possible, however, to put air into a fairly good conducting state. A simple experiment will illustrate one means of doing so. Suppose a lighted match is held near the projecting end of a charged electroscope. It will be found that in a few seconds the leaf has fallen and the electroscope is discharged. The air in the neighborhood

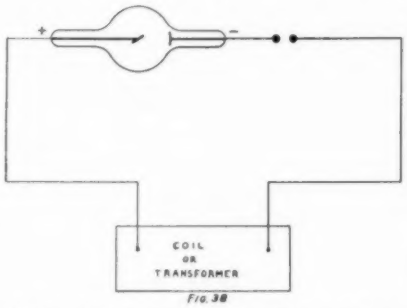


FIG. 38

of the electroscope has had its conductivity enormously increased by the presence of the flame. In other words, the flame is what we call an *ionizing agent*, causing marked ionization of the air in its neighborhood. An explanation of the meaning of ionization can best be given with reference to one or two further experiments.

Suppose we have an arrangement of apparatus similar to that illustrated in Figure 41. In this case air from the neighborhood of a flame may be sucked through a tube LM, into which projects the top K of the insulated rod of a charged electroscope. With such an arrangement it will be found that as soon as the air from the flame is sucked along the pipe, the electroscope begins to lose its charge. Evidently air in the conducting state can be carried from place to place.

Imagine next, that the apparatus is altered so that the ionized air in its passage along the tube has to pass between two plates P_1 and P_2 (Figure 42), which are joined one to the positive, the other to the negative terminal of an electrical machine or high voltage battery. It will now be found that, in spite of the suction through the tube, the electroscope *retains* its charge. In other words the conducting air, after passing between the charged plates, has lost its conductivity or is no longer ionized.

The removal of the conductivity by the charged plates (and many other experiments) suggests that air is made a conductor because of the formation by the flame of small electrified particles or *ions*. This provides a ready explanation of the discharge of the electroscope. If it is positively charged, and ions are formed near it, positive ions will be repelled, negative attracted. Each negative ion, on reaching the insulated rod of the electroscope, will annul some of the positive charge on it until finally the electroscope is completely discharged. Moreover, all the time the discharge is taking place, *there is a stream of positive ions in one direction, negative in the opposite*. Such a stream of ions constitutes an electric current through the air.

Ions and Electrons

42. But, it is asked, what *are* ions? As a result of the work of the physicist in the last twenty or thirty years, the answer may be given with some confidence. It is now believed that an atom (of an element) consists of a core or nucleus, positively charged, together with a certain number of small negatively charged particles, called *electrons*. In spite of the attraction of positive for negative, the electrons do not "fall into" the nucleus, probably because of their planetary motion about it. (The earth for the same reason, does not fall into the sun.) The nucleus, which is responsible for practically the whole mass of the atom, has a different constitution for each atom; electrons, however, whose mass is about 1/1800 of that of a hydrogen atom are identical in all atoms (See Section 46 below). The *number* of electrons, however, increases with the atomic weight of an element. For example, there is much evidence to indicate that the hydrogen atom has only 1 electron, helium 2, lithium 3, and so on until we reach heavier elements such as mercury with 80 electrons. (It is now generally accepted that the number of electrons in an atom is equal to the number of the element, when the elements are arranged in the order of increasing atomic weight, the so-called *atomic number.)*

Normally, the negative charge on the

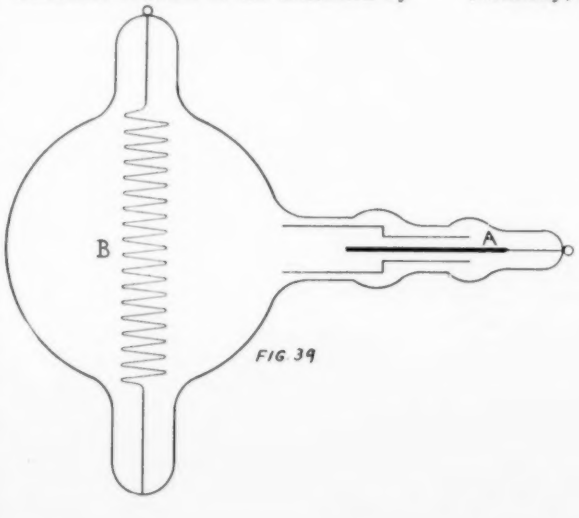


FIG. 39

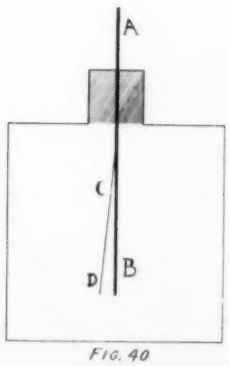


FIG. 40

electrons exactly neutralizes the positive charge on the nucleus, so that the atom in its ordinary state is electrically neutral. If, however, *by means of an ionizing agent such as a flame, an electron is removed from the parent atom, it should be evident that what is left will be a particle of atomic size, with an excess of positive electricity, or a positive ion.* The electron which has been removed may either remain "free" or attract to itself one or more neutral molecules, or atoms, thus forming what is called a negative ion.

Later we shall see that one of the most important properties of x-rays is their ability to ionize a gas.

(It should now be evident that, to account for the extremely slight conductivity of ordinary air we must assume the existence in air at all times, of a few stray ions.)

Conductivity of Air at Pressures Less than Atmospheric

43. In this course, we are interested particularly in the conductivity of air at pressures considerably less than atmospheric. Suppose that the terminals of an x-ray bulb or any "vacuum" tube with electrodes A and B (Figure 43) are joined to an induction coil or a high tension transformer. Suppose, further, that the tube at the start contains atmospheric air, and that the electrodes are at such a distance apart that no spark discharge can take place. If now, by means of an exhaust pump, the air is gradually removed from the tube, a stage will soon be reached at which a discharge passes readily—this stage being indicated by a line of luminosity which extends from one electrode to the other. As exhaustion proceeds the current passes more and more readily until a second stage is reached beyond which the current passes less readily until finally, when a very high vacuum has been attained, the resistance is so great that the tube will not conduct at all. Some actual measurements (taken from Townsend's *Electricity in Gases*) are given in Table III. This table gives the voltages necessary to maintain a current of 10 ma. through a tube 3 cm. in diameter, with electrodes 11.5 cm. apart, at various pressures.[1] It will easily be seen that as the pressure lowers, at first a lower and lower voltage is required, but after a certain critical value has been reached, higher and higher voltages are necessary. Evidently, then, *the resistance of a vacuum tube or a gas x-ray bulb depends on the degree to which it has been exhausted.* Moreover, after a certain critical pressure has been passed, it is more and more difficult to pass a given current through an exhausted tube. Technically, it is said that the tube becomes *harder and harder*, as the pressure gets lower and lower. The harder a gas x-ray tube is, therefore, the greater the voltage necessary to maintain a given current through it.

TABLE III.

Pressure	4 mm.	2.84	1.65	1.04	.66	.4	.29	.24	.17
Voltage	650 volts	620	500	470	490	530	590	630	740

The Appearance of a Vacuum Tube Carrying a Current

44. The appearance of a vacuum tube when conducting a current at low pressures is very beautiful, and has certain general characteristics which it is well to note. Initially, or very shortly after the gas has become conducting, a single sharp narrow streamer extends the length of the tube. As the pressure is reduced, the band of light becomes wider and more and more diffuse until the whole tube is filled with luminosity. At still lower pressures (of the order of half a millimeter), the tube has a striking and very characteristic appearance: (1) around the cathode is a thin luminous layer, A in Fig. 44; (2) next is a *sharply* defined dark space B, followed by, (3), another luminous region C, then (4), a second ill-defined dark region D, and finally (5), a column of luminosity E, extending to the anode. At certain pressures this column is broken up into beautiful striations, that is, narrow regions alternately dark and light.

Most important of these regions is the sharply defined dark space, the Crookes' dark space, as it is called, or sometimes "the" dark space. With decreasing pressure, its width continues to increase, and is indeed a rough measure of the degree to which the tube has been exhausted. In the case of a gas x-ray tube, the dark space should fill the whole tube. If by any chance any x-ray bulb presents the above appearance, that is, one with marked luminosity, the pressure is much too high and the tube must be re-exhausted before it is of any use. In the case of a Coolidge tube, careless manipulation may result in the liberation of gas. If sufficient gas is present, this will be evident by the general luminosity filling the tube when a high voltage is applied. Again, re-exhaustion is the only remedy.

Cathode Rays

45. When exhaustion is extended beyond that giving rise to the above characteristic appearance, the dark space, as already noted, grows wider and wider until it finally fills practically the whole tube. This occurs at what we may call the x-ray vacuum, for the pressure has now been reduced[2] to about 1/100 mm., that it, to a value which is about the order of that in a gas x-ray bulb.

At this pressure a very faint beam of light proceeding *at right angles* to the cathode is frequently visible. Depending on conditions, this beam may be narrow, covering only a small portion of the face of the cathode, or it may cover nearly the whole of it; it may be extremely faint, or it may be well defined. (Often it is quite visible in a "soft" x-ray bulb). The direction of this beam, moreover, is independent of the position of the anode. For example, in a tube of the shape illustrated in Figure 45, the beam is still at right angles to the cathode, although the anode is in an arm at one side of the tube.

A second important appearance is characteristic of this stage. The walls of the tube, particularly at the end opposite the cathode, are seen to fluoresce with a light, frequently greenish, but whose colour depends on the composition of the glass. That the fluorescent light has some connection with the faint streamers, is readily shown by simply bringing one pole of a magnet near the cathode end of the tube. Both the faint beam of light and the position of the fluorescent light at the other end move simultaneously.

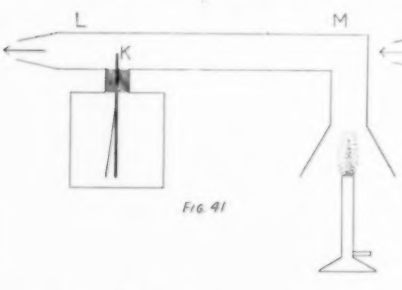


Fig. 41

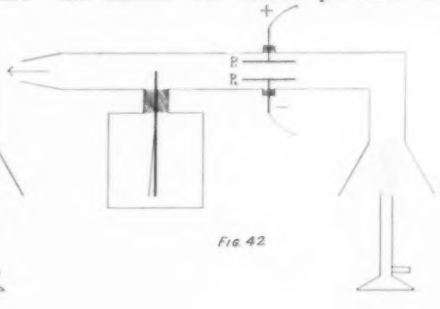


Fig. 42

Fig. 43

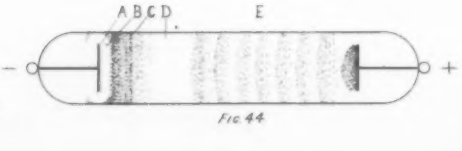


Fig. 44

The name *cathode rays* has been given to the faint beam of light. What is their nature? Before answering this question it is desirable to look at some properties of the rays: (1) From what has just been stated, cathode rays are deflected from their path by a magnetic field, and (2) excite fluorescence where they strike the walls of a glass tube. (3) They travel in straight lines. This is readily shown by using a tube of the kind illustrated in Figure 46. With such a tube it is observed that if an obstacle P is placed in the path of the rays, a *sharp* shadow is cast on the end of the tube, all the region around the shadow strongly fluorescing. This could be caused only by a beam which, like light rays, travels in straight lines. (4) Cathode rays represent a considerable amount of kinetic energy. This may be shown by using, not a plane cathode, as represented in Figure 45, but a concave one. By this means the beam of rays (which it was pointed out above proceed normally from the cathode) can be brought to a focus at a point, as illustrated in Figure 47. If, now, a thin piece of metal be placed in a tube so that the spot to which the rays are focused is on the surface of the metal, in a short time incandescence will be observed in the neighborhood of the spot. On impact of the rays against the metal a large amount of heat is developed. (This point is of very great importance in connection with the action of either the gas or the Coolidge tube).

(5) Cathode rays are deflected from their path by an *electric* as well as by a magnetic field. To show this a tube constructed as represented in Figure 48 is used. Two pieces of metal A and B with small axial holes are inserted in the tube near the cathode, so that a narrow pencil of cathode rays may be obtained. This beam may be visible for only a short distance from the cathode, if indeed it can be seen at all, but, if at the far end of the tube, a fluorescent screen S be placed, the presence of the rays is at once evident by a round fluorescent spot at O on the screen. Suppose, now, the tube has been constructed with two metal plates P_1 and P_2 and that these are joined, one to the positive, the other to the negative terminal of a battery. It will then be found that the spot of light shifts from O to K. *In their passage through the electric field between the plates, the rays have been deflected.*

From this and the other properties enumerated, we conclude that cathode rays consist of *a stream of electrified particles*. Moreover, from the direction of the deflection by the electric field, the charge they carry is at once seen to be *negative*.

46. How big are these particles? How fast do they move? The answers to these questions are found in quantitative experiments made with tubes of the nature of that shown in Figure 48. Without going into details, it should be evident that the amount of the deflection OK will depend both on the *speed* of the rays and on their *mass*, as well as on the strength of the deflecting electric field. The faster they travel, and the bigger their mass, the less will be the deflection in any given field. By measuring deflections, therefore, for electric (and magnetic) fields of known strength, it is possible to obtain values of the mass and of the speed of cathode rays. Such measurements show that the mass of each particle in a beam of cathode rays is about 1/1800 of that of a hydrogen atom. The speed varies with the voltage applied across the tube, but may be of the order of 60,000 miles a second.

Another remarkable fact is evident from such experiments. No matter what gas is used in the vacuum tube, and no matter what the metal used for cathode, the mass of a cathode "ray" is always the same. The general conclusion is obvious: *Cathode rays are just electrons which have been liberated from the atoms of elements and shot down the tube from the region of the cathode. They are high speed electrons.*

Origin of X-rays

47. When cathode rays strike a metal surface (a target) placed in their path, a new kind of radiation originates at the place of stoppage. These new rays, which possess the remarkable property of being able to penetrate thick layers of apparently opaque substances, are called roentgen or x-rays. The first name is in honour of their discoverer, Roentgen; the second indicates the uncertainty regarding their nature which obtained for some years after their discovery. Later we shall discuss their nature and general properties; at present we are concerned with the mode of obtaining x-rays. This can be done only by having high speed electrified particles (electrons) suddenly stopped.

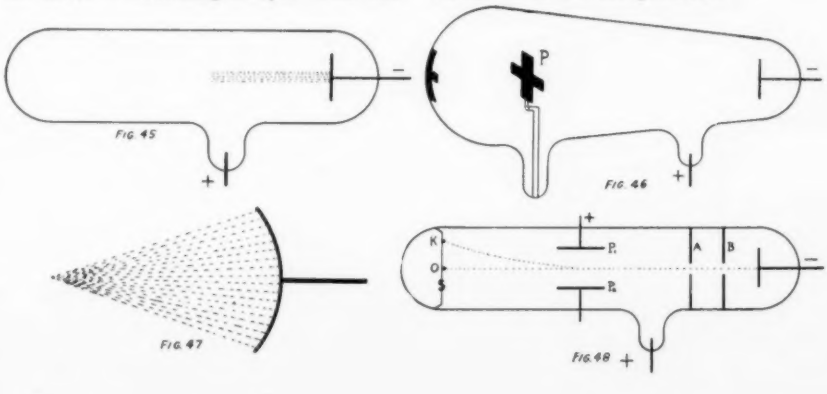
To obtain a supply of such electrons, two totally different means are utilized. In the first method (the gas x-ray tube) enough gas is left in the exhausted tube so that when a high voltage is applied to the electrodes, a current is conducted across the tube by means of a flow of ions, positive towards the cathode, negative to the anode. Now, it has been shown experimentally that between the cathode and a region very close to it there is a big drop in voltage. Accordingly, when the positive ions get near the cathode they are shot (or pulled, if you like) at high speed against it. As a result electrons are liberated either from the gas immediately before the cathode or from the metal of the cathode itself (it cannot be said with absolute certainty which is correct). These liberated electrons in their turn are shot, as a beam of cathode rays, away from the cathode, and when suddenly stopped give rise to x-rays.

In the second method, as exemplified by the Coolidge and the Lilienfeld tubes, there is not enough gas left in the tube to conduct a current, even with extremely high voltages, and electrons are obtained in an entirely different manner. Before beginning a discussion of the new principles underlying the use of these tubes, however, it is desirable to examine in detail the construction and the operation of the gas bulb.

Footnotes

1. Readers will recall that the pressure of a gas is frequently expressed in terms of the length of the column of mercury it will support. Atmospheric air, for example, will support a column of mercury which varies from day to day, but is in the neighborhood of 760 mm. In the experiment to which Table III has reference, an air pressure has been reached which supports only a column of 17/100 mm. of mercury.

2. We speak of raising the vacuum when we lower the pressure.



The Auto-Electronic X-Ray Tube of Lilienfeld*

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THERE are two types of tubes in general use. These types differ mainly in the method by which the electrons essential for the bombardment of the target are produced. They are: (a) the hot cathode tubes (thermo-electronic), and (b) the gas tubes (ionic).

The Hot Cathode Tubes (Thermo-Electronic)

In the hot cathode type of tubes represented by the Coolidge hot cathode tube in this country and the Lilienfeld hot cathode tube in Germany, the electrons are produced from a cathode of a wire of suitable material (tungsten, tantalum) through heating by an electric current. The vacuum of the tube is very high, at least twenty times that of an ordinary gas tube, and no discharge can pass unless the cathode is heated.

The Gas Tubes (Ionic)

The exhaustion of the gas tube, on the other hand, is never so high, traces of gas being left in the tube. In this type of tube ions in the residual gas are the source of the electrons. When the tube is energized the electric field disintegrates the electrified atoms into positive and negative ions. Some of the negative ions become embedded in the glass walls of the tube and this is responsible for the gradual hardening of the gas tube. The positive ions are driven against the cathode, the bombardment of which results in the release of electrons. In their rush to the anode these electrons ionize the atoms of residual gas, thus further producing more positive ions and electrons. The electrons produce the x-rays by impact against the target.

In the hot cathode tube it is possible to vary the voltage independently of the current, for the current is limited by the number of electrons emitted from the cathode and this is controlled by the heat produced in the cathode filament. In the gas tube, on the other hand, the current increases with the voltage.

Kaye has pointed out that since the hot cathode tube utilizes its "saturation" current its spectrum is much less affected by changes in the wave form of the exciting potential than the gas tube, in which the absence of saturation permits a more effective use of very high voltages with a greater output of radiation from the input of the same quantity of energy.

*—Received for publication June 4, 1922.

To these two types, Lilienfeld has now added a third type of tube, the autoelectronic tube.

The Autoelectronic Tube

The vacuum of this tube is very high, the exhaustion being considerably greater than that of the hot cathode type of tube. It is nevertheless possible to directly energize this tube, by virtue of a special construction and arrangement of the cathode and anode by which electrons are liberated from a cold cathodal surface.

Lilienfeld claims that in this new type of tube the electrons are released by a phenomenon which he is the first to have observed, one in which ionization plays no part whatever. That is to say, there is neither the ionization of the residual gas nor the ionization through a hot spark discharge between the anodal and cathodal surfaces. It is primarily the intense electrostatic field (created by a certain construction) which pulls the electrons from the cold metallic cathode.

This tube differs, therefore, from the hot cathode tubes in that the cathode is and remains unheated and from the gas tube in that there is no ionization of the residual gas. The striking difference in construction between this tube and the gas or Coolidge tube lies in the form of the cathode, which is a sharp point, and in the relationship as regards position of the anode and cathode, which are comparatively close together (about 6 mm.).

The Tube

The tube is a spherical bulb about thirteen centimeters in diameter, having three or four extensions, depending upon the number of cathodes. The anodal extension has the characteristics usually found in anodes with water-cooling devices. The cathodal extension is narrower and supports the cathode. Where there are two cathodes the glass extensions make a slight angle with each other, the terminals being separated for a distance of ten centimeters. Opposite the cathodal extension is a chamber with a sputtering device for raising the vacuum. This plays no part at all in the activation of the complete tube.

The Cathode

The cathode is a wire with a pointed tip. This projects from a small collar at the neck into the bulb in a direction parallel to the axis of the tube for a distance of about six centimeters. At this point it is bent towards the anode at about an angle of one hundred and thirty-five degrees, the inclined portion being about two centimeters in length. The pointed end of the wire cathode approaches the anode or target to within a few millimeters, projecting into a depression on the anodal surface. It is this depression which acts as the focal spot. The tube may have one or more cathodal points. These points may project into the same anodal depression or into individual anodal depressions. The pointed ends of the cathode vary in sharpness. Until now three varieties of cathodes have been produced, the sharp point, which is called the "S" or "soft" point; the blunt point, which is called the "H" or "hard" point; and a point of medium sharpness, which is called the "M" or "medium" point. These have their applicability for the production of radiations of different penetration as will be indicated later on.

The Anode

The anode consists of a copper head into which is inserted a tungsten button. The true anodal surface—the target—is entirely of tungsten. The copper head shows a smooth depression along the surface directed towards the cathode. At the very edge of this tungsten button below the depression in the copper carrying stem are one or more small pits or depressions. This grooves both front and side of the tungsten button equally. It is these depressions in the anode which act as the focal spots and into which the cathodal points project between the anode and cathode. Owing to the short distance and the depression in the anode, the secondary electrons cannot leave the focal area, consequently the number of electrons making impact against the stem is greatly reduced as compared to the Coolidge tube. This, of course, conspicuously diminishes the extent of stem radiations and makes for better definition and contrast.

Connections and Operation

The tube is connected in the usual way, just as a gas tube is connected. The anode water-cooling device is connected to the positive wire and one of the cathodes to the negative wire. There is only one accessory device to the ordinary installation use for the gas tube. This is a resistance, consisting of carbon coating on the inside of the glass tubes. These are connected, one at each terminal in series with the tube. These resistances are not essential, but are valuable in that they dampen the high frequency oscillations of the transformer.

When energized the tube has a feeble irregular fluorescence in several parts. The fluorescence of the glass in the frontal part, which is visible only in the dark, is due to the impact of the

x-rays against the wall. There is also some slight fluoresence about the neck of the anodal extension. The shadow of the anodal stem is visible on the back part of the bulb and the shadow of the cathodal point is visible on the frontal part of the bulb. At low load, the depression glows with a bluish haze. Increasing the load produces a brilliant white glow in the depth of the depression without disintegration. There is apparently no movement of the focal point with heavy loads. Even should movement occur, it can only take place within the anodal depression and there would not be any blurring of the radiograph, because the entire depression really acts as the focal point.

There is no heating of the cathode by the discharge current, no cathodic disintegration nor could any change in the conformation of the cathodal point be detected after usage. There is a gradual but slight tinting of the glass with usage. There is no metallic deposit on the glass.

The tube acts as a valve and does not at any time allow the current to pass in the inverse direction.

No milliamperage is appreciable until a certain voltage—critical voltage—is attained. The value of this critical voltage depends on the characteristics of anode and cathode, in other words, upon the shape and size of the cathodal point, size of the anodal depression and the geometric relationship of anode to cathode. This has an important bearing on the use of this variety of tube for therapy. For the relationship of the parts may be so made that this critical voltage be as high as 60,000 or 70,000 volts. Thus the generation of those softer radiations by the lower voltages may be entirely eliminated.

As the voltage is increased a definite current value is obtained for each voltage, the current gradually increasing, as the voltage is raised. In this respect the tube resembles the gas tube, but the definite current value for each voltage is constant for the particular tube at all times, in which respect it is far superior to the gas tube. The sharper the point of the cathode the more rapid the increase of current and the greater the current value for the same voltage. Coincident with the increase in the voltage there is an increase in penetration with increasing current up to a certain point. Beyond this slightly increasing the voltage produces a great increase of the current, so that roughly speaking there is no appreciable increase in penetration with increasing current.

Testing one of the tubes the value of the discharge current for each voltage was tabulated, first with the "S" point and then with the "H" point.

"S" Point		"H" Point	
Spark	Ma.	Spark	Ma.
(3)	1.8	(4¼)	½
(4)	4½	(4¾)	2
(4½)	8	(5¼)	3.2
(4¾)	9½	(5½)	4
(5¼)	13½	(5¾)	6.4
(5½)	15½	(6½)	10
(5¾)	23		

It is noticeable that for the same voltage there is a smaller milliamperage with the hard point than with the soft. The values indicated on the curves are not interchangeable. In other words, a certain milliamperage at a given voltage on the "S" point cannot be utilized for the same purpose on the "H" point. The resulting radiographs have different characteristics. This is due to the amount of the current wave which is utilized by the particular point. More of the curve is utilized by the "S" point than by the "H" point, which simply utilizes the peaks. It is for this reason also that primary voltage readings are not an accurate indication of the impressed voltage across the tube terminals because the characteristic of the tube distorts the form of the wave. Measurement by spark gap shows that with the same primary voltage, the spark gap value is somewhat less with this tube than with the hot cathode, under identical conditions. The penetration for either point "S" or "H" increases at first definitely with the increased primary voltage and then practically not at all, the only result being increased current without any conspicuous increase in penetration. Any degree of penetration can, therefore, be obtained by selecting the proper point and the proper load and this is constant for the thickness of tissue and with the same recording surface and distance there is an exact time value at which a proper record of densities is obtained. So that the final exposure table with these new tubes will give tissue thickness in inches (point), load and time as the important factors.

Exposure Table

The "S" or soft point, is to be utilized for the radiography for the less dense portions of the body, as the extremities, the head in the lateral position, the urinary tract, the chest. The "H" or hard point is to be utilized for the radiography of the hip (for bone disease), the head in the saggital position, the gastro-intestinal tract.

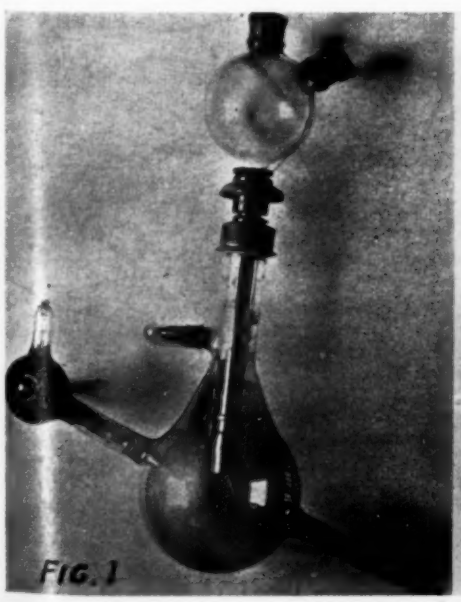

Fig. 1—Lilienfeld tube, side view.

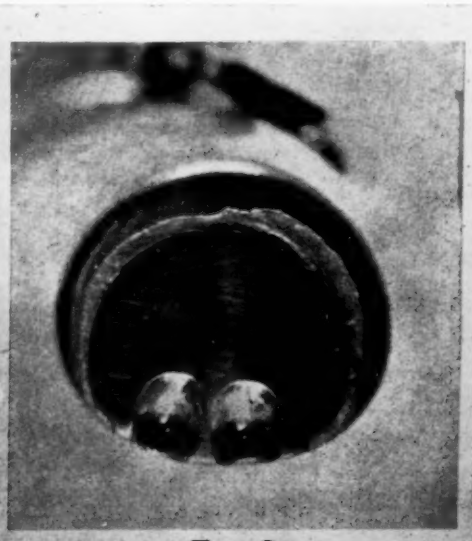

Fig. 2—Anode head, showing two depressions which have focal heads.

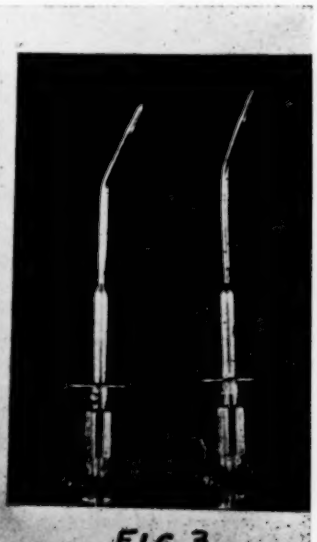

Fig. 3—Cathodes, sharp and blunt point.

Duplitized Films—Normal Developer—"S" Point

58000 volts (auto-transformer)
12 milliamperes, Focal Distance 24-in.

Phalanges	1/6	Wrist	1/4
Tarsus, Ap	5/24	Forearm	1/2
Lat.	1/4	Elbow	1/2
Ankle Ap.	1/2	Arm	3/4
Lat.	2/3	Shoulder	1
Knee Ap.	3/4	Cervical spine,	7/8
Lat.	1	Head lateral	2
Thigh	1 1/4	Mastoids	2
Fingers	1/6		

Urinary tract 4½, 55,000 volts, 9½ milliamperes.

Chest ⅜, 83,000 volts, 35 milliamperes, Focal distance 28 inches.

"H" Point

Head 5, 90,000 volts, 7½ ma.
Hip 3, 80,000 volts, 6½ ma.
G. I. Tract, 1/20 screen.

¼ sec., no screen, 80,000 volts, 25 (?) milliamperes, focal distance 28 inches.

Characteristics of the Radiograph

The definition is fine, the plates show the absence of blurring or fogging, the contrast is good with distinct gradations and the high lights or areas of maximum density are of a dense jet black color. The improved quality of the radiograph is due not so much to the great intensity and the relatively small focal point as to the absence of the stem radiations.

The chest plate shows fine contrast with a wealth of sharply outlined detail.

The gastro-intestinal examination can be made without screens. As compared to screen negatives the former lack contrast, but there is more sharpness and definition. It would seem, judging from the radiographic effects, that this tube gives at least four times the x-ray output of a Coolidge tube and twice the output of a medium vacuum gas tube.

The experience with the tube is naturally still limited and usage and experience may compel a modification of the present feeling that this new tube, with its high intensity of radiation permits a great stride in the proper direction—in the direction of simplicity of technique, shortness of exposure time and fine radiographic definition.

Fluoroscopy

For this purpose the connections are as above described. The only maneuver is the necessity of keeping the water-cooling device filled with water. The tube works steadily, giving excellent definition and fine contrast with three milliamperes and 60,000 volts.

Comparison of the Various Types of X-Ray Tubes

Characteristics	*Gas*	*Thermoelectronic*	*Autoelectronic*
Stability	Unstable — continuous regenerating required	Stable — If the heating current is controlled	Continuously stabile
Variables to be observed	3: Voltage Milliamperage Gas pressure	3: Voltage Milliamperage Amperage of heating apparatus	1: Either voltage or milliamperage
Photoactive radiation from focus for a given voltage and mills per unit	2	1	6-8
Photoactive radiation outside the focal point.	Front part of glass bulb	Stem radiation	Negligible
Definition of radiographic, fluoroscopic image	Good	Fair	Good
Homogeneity	Medium	Minimum	Maximum
Average hardness at given voltage	Medium	Low	High

Comment

The advent of the hot cathode tube marked an epoch in the development of roentgenological technique. In contrast to the gas tube, the hot cathode tube was an instrument of precision and stability, an instrument capable of fairly accurate adjustment and by which a duplication of results was possible. With the advent of the hot cathode tube the worker was now enabled to measure the factors concerned in the making of the examination.

Devoid of the vagaries of the gas tube, by virtue of its very high vacuum, the ease of adjustment and control gives the hot cathode tube a tremendous advantage over the old form of roentgen tube, which it rapidly superseded in this country. On the other hand, almost from the beginning there have been difficulties with this type of tube. These difficulties arose from three sources: firstly, from the maintenance of the constancy of the cathode filament current value; secondly from the relatively broad focal spot of the tube and from the superabundance of radiation from other regions than those of the focal point of the anode; and thirdly from the smaller output of radiation from the Coolidge than from the gas tube under the same working conditions.

1. The accessory installation imposed by the filament circuit added a new responsibility to the technical equipment and brought with it all the difficulties associated with the care of a low tension circuit. It was soon found that accurate adjustment was not easily maintained, since marked variations in tube current followed the slightest changes in filament heat. The storage battery as a source of supply was rapidly abandoned for the more stabile step-down transformer.

That the important problem of stability and accuracy of adjustment is, however, not yet entirely solved, is proved by the recent appearance of stabilizers warranted to automatically control tube current fluctuations. It cannot be denied that the low tension circuit complicates rather than simplifies our technique.

2. It was not long before the examination of our radiographs disclosed to us the fact that we were dealing with relatively broad focus tubes, as compared to the gas tubes, even when we were utilizing the fine focus Coolidge tube and that comparatively clear radiographic definition could only be obtained with the very fine focus—the latest development, the radiator 30 milliampere tube. But here we were confronted with the difficulty of the limitation of the energy input incidental to the size of the focus itself, and because of the low milliamperage, necessitating a prolonged exposure and where a shortened time was necessary, we were driven to use the intensifying screen. And just now we are ploughing through a period where the tyranny of the screen holds complete sway. The intensifying screen is a nuisance and abomination in the x-ray laboratory. It is an accessory device which might be well dispensed with. It adds additional maneuvers and procedure to the already complicated procedure incidental to the

making of the radiograph. It entails additional duties and observances on all concerned in the laboratory. It is costly. In the early days of radiography the feeble output of the tubes demanded its use, even for making exposure of the softest parts of the body. But now when our apparatus permits us to produce a radiation of enormous intensity, it does seem anomalous that the intensifying screen is still so generally utilized.

The attempt to obtain better radiographic definition with the broader focus hot cathode tubes, by increasing the target plate distance, only again drives us to the use of intensifying screens by the rapid increase of time, imposed by the inverse square law.

But more important as a cause of the lamentable lack of fluoroscopic and radiographic definition of the hot cathode tube are the indirect radiations, in other words, radiations from other sources than the the focal point of the target (notably the stem) with the consequent increase in secondary radiations from the object.

Close diaphragming and compression have not been sufficient by any means to eliminate this most important cause of poor radiography. Recently, however, the ingenuous Bucky diaphragm has been applied to this problem, but one must concede that the problem of technique has again not been simplified by this further addition of this accessory to our radiographic armamentarium.

For balanced against its "clean-up effect and the contrast and crispness which it helps to produce" is the necessity for increased penetration, increase in focal distance, marked increase in time, and, therefore, the use not only of single but double intensifying screens.

This is the present status of the radiographic technique, apparently daily growing more complex, with additional circuits, stabilizers, complicated diaphragms and double intensifying screens. The time is ripe for the advent of a new tube or a modification of the old that we may cease regretting our achievements with the gas tube. And if further experience with a definite type of this new x-ray tube bears out the results of the experiments with the models then indeed a great stride in the direction of simplicity of technique, shortness of exposure time and fine radiographic definition will have been made.

Summary

1. This, then, is a high vacuum tube, which may be called an auto-electronic tube, in contradistinction to the hot cathode (or better thermo-electronic tube), in which tube and electrodes are freed from gas to a point far beyond that obtained by any form of hot cathode tube.

2. This new high vacuum x-ray tube has an unheated cold cathode, the electrons being liberated at the cathode by the action of the electric field only.

3. The characteristics of the tube are invariable and fixed and dependent only on the geometrical arrangement of the electrodes.

4. The voltage and the magnitude of the current are under control, but not independently of each other.

5. In this new tube the milliamperage increases with the impressed voltage in a certain definite function.

6. There is a minimal variable critical voltage which is about 70 per cent of that utilized in active operation below which no discharge is apparent in the tube.

7. Under the same voltage and milliamperage the x-ray output of the new tube, as judged by comparative exposures has at least five times the intensity of the hot cathode tube.

8. The technique of the use of this tube is extremely simple.

9. The roentgen image (screen and plate) is characterized by definition and fine contrast, because of the minimal amount of radiation emitted from other points than the focal spot (stem radiations, radiations from the glass, etc).

10. The characteristics of the radiograph may permit the discarding of the accessory devices as screens, diaphragms, etc.

11. With the same voltage and milliamperage, the average hardness and homogeneity of the radiation is much higher than with the hot cathode tube. This is due to the form of the function characteristic of the discharge in the tube.

12. This considered with the high intensity and the high critical voltage, indicates the applicability of the tube to most exacting demands of modern deep therapy.

EDITORIAL

The JOURNAL OF RADIOLOGY

A Journal of ideas and ideals.

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Science and History

HENDRIK von Loon recently made some remarks which are very pertinent at this time because of their reflection of the current thought about things scientific. In substance, he said that the historians had been responsible for all wars because of the manner in which they had recorded historical events, that they had placed undue emphasis on nationalism and too little emphasis on events of an international nature. To drive home his point he used two concrete illustrations. He is reported to have said that if one goes to the public library he will find many, many volumes recording the events which occurred during the reign of King Charles II, the stress being placed upon the acts of the king himself. After reading these volumes, one gathers the impression that all events of that period gather around King Charles until in a small footnote somewhere it is discovered that during the reign of King Charles II a young scientist, Isaac Newton, was lying on his back under an apple tree one day. While lying there, he saw an apple fall from the tree to the ground. From this simple commonplace occurrence, Isaac Newton deduced the Law of Gravitation and many other physical principles related thereto. According to Hendrik von Loon, if history were properly recorded, there would be many, many volumes telling about the discovery of the Law of Gravitation by Isaac Newton and in a footnote somewhere one would read that King Charles II was reigning when these momentous discoveries of nature's law were being made. The Law of Gravitation is interrational, affecting all beings wherever located without regard to political boundaries, while the deeds of King Charles II were of chief interest to a small group of individuals who happened at the time to live in his domain.

As a second concrete illustration of his meaning, Hendrik von Loon told of how if one goes to an American public library he will find books entitled, "Roosevelt the Roughrider," "Roosevelt at San Iuan Hill," "Roosevelt the President," "Roosevelt the Man," "Roosevelt in Africa," "Roosevelt in South America," " Roosevelt the Writer," etc., and somewhere a brief mention of the fact that during President Roosevelt's administration two Ohio boys did something which had never before been done since the world began—they made man fly. Mr. von Loon is reported to have continued that Roosevelt was a great man. We needed him when we had him and we had him when we needed him. Had history been properly recorded there would be volume after volume telling of the international significance of the invention of the aeroplane by the Wright brothers and only brief mention of the doings of the great nationalist, the late President Theodore Roosevelt.

It would appear that the emphasis laid upon the international scope and influence of science by the historian, Mr. von Loon, is an index of popular thought at this time. Especially is this true when it is recalled that the remarks just recorded called forth loud applause from the large audience of the Omaha Society of Fine Arts to whom he was speaking.

Many others have called attention to the importance of science to humanity, using the pages of the popular magazines as their avenue of approach. That there is a popular demand for this kind of material is quite evident from the increasing number of articles now appearing in different magazines. The Saturday Evening Post is carrying a series of articles by Floyd W. Parsons, the second of which is entitled, "*Questions That Science Will Answer*," in which much stress is laid upon the importance of scientific achievement in the uplift of the human family. In the article appearing March 31, he, in substance, says that the most important branch of science is that which is connected with medical endeavor because thereby public health is conserved. All other lines of scientific endeavor are subordinate to those which contribute to the saving and prolonging of human life. That the importance of this kind of scientific effort is realized by those doing it is evidenced by the self sacrifice of many. Mention need scarcely be made of the hardships endured by Harvey, Pasteur and many others whose names are now immortal. The spirit of these men is beautifully described by Henry Drummond in *The Ascent of Man*, page 232, from which we quote:

> "To interpret the course of Evolution without this (law of sacrifice) would be to leave the richest side even of material nature without an explanation. Retrace the ground even thus hastily traveled over and see how full creation is of meaning, of anticipation, of good for man, how far back begins the undertone of Love. Remember that nearly all the beauty of the world is Love. Beauty—the corolla of the flower and the plume of the grass, the lamp of the firefly, the plumage of the bird, the horn of the stag, the face of a woman; that nearly all the music of the natural world is Love. Music—the song of the nightingale, the call of the mammal, the chorus of the insect, the serenade of the lover; that nearly all the foods of the world are Love. Foods—the date and the raisin, the banana and bread-fruit, the locust and the honey, the eggs, the grains, the seeds, the cereals and the legumes; that all the drinks of the world are Love. Drinks—the juice of the sprouting grain and the withered hop, the milk from the udder of the cow, the wine from the Love-cup of the vine. Remember that the Family, the crown of all higher life, is the creation of Love; that Cooperation, which means power, which means wealth, which means leisure, which therefore means are and culture, recreation and education, is the gift of Love. Remember not only these things, but

the diffusions of feelings which accompany them, the elevations, the ideals, the happiness, the goodness and the faith in more goodness and ask if it is not a world of Love in which we live."

Mr. Drummond is here laying stress upon the spiritual side of scientific advancement and correctly so, for after all this is the guiding star which leads the research worker on and sustains him until such a time as the rank and file recognize the value of his work.

The advances in science in recent years have linked the material and the spiritual more closely together. The marvels of the spoken voice, as revealed by the modern method of radio-transmission, inspire one with reverence for science and the great power back of it all.

The discovery of radioactive substances opened a complete new world to science, completely changing the arrangement of the elements and proving true to a certain extent, the old time theory of "transmutation of elements" which had previously been discarded. Professor J. Arthur Thompson in his *Outline of Science*, calls to our attention the value of radiant energy to mankind in the following words: "Energy is indispensable if the world is to continue to exist, since all phenomena, including life, depend upon it."

Radiant energy is the acme of all energy and with this powerful agent the radiologist is working continuously. The importance of this branch of medicine is becoming more clearly recognized day by day. Laymen nowadays who suffer some injury, request immediately that the physician employ the x-ray as a diagnostic aid in determining the extent of their injury. Such great value has this method of examination that the courts in several states have ruled that the physician who fails to take advantage of its help where at all possible, is guilty of neglect of the best interests of his patient. The therapeutic value of x-rays, radium rays, ultraviolet rays and many other portions of the spectrum, is becoming rapidly known by the layman as well as by the physician. It has frequently been the experience of physicians to have a patient suggest that he be treated by some of the forms of radiation just mentioned. This experience means that these physical agents will be employed by increasingly greater numbers of physicians as time goes by.

From an organizational standpoint, then, the field of the Radiological Society and the Journal of Radiology is unlimited. With every member's shoulder to the wheel pushing forward, there is no limit to possible accomplishment. The science of radiology can be made bigger and better by the cooperative effort of all men working in this field. The man who is serving the smaller community has no less responsibility than the man in the large city. The illustration cited by Dr. W. Warner Watkins in an able editorial in the February number of the Journal of Radiology hits the nail on the head. He tells how, in a certain community of approximately 10,000 inhabitants, one of the physicians in general practice took up radiology, secured the cooperation of all the other physicians, and, developing his powers as the demands upon them increased, built up a large practice in radiology. Radiologists who have had experience in general medicine before specializing, make better radiologists than those who have not had this experience. This is true because it gives them a broader viewpoint and a better knowledge of anatomy, physiology and pathology which are the foundation stones upon which all diagnosis is built. The Radiological Society, then, needs this type of man in its membership and by securing the cooperation of all interested in the specialty of radiology, greater good will come to all concerned.

The Sultan of Sulu and the X-Ray

HOW the use of the x-rays gained a diplomatic victory over the Sultan of Sulu some years ago is a fascinating story related for the first time.

When the United States acquired the Philippine Islands, the Sultan of Sulu, at first, kept his people as quiet as possible under the rule of the United States. One day, however, the military officer assigned to control, in telling the Sultan about the wonderful inventions of the Americans, described among other things the method of looking through the body with the x-rays. He told the Sultan that the bones of the hand could be seen with the x-rays just as plainly as though the flesh had been stripped off.

This was too much for the Sultan's credulity. He assumed a disagreeable attitude toward the military officer, whose influence began to wane. He told his people that the Americans were such great liars that no confidence could be placed in any of them and it was not long until he was demanding a greater pecuniary allowance in return for keeping his people in a friendly attitude toward the Americans. Thereupon the military governor was directed to bring the Sultan to Manila in order that his demands might be investigated. When the military authority with the Sultan and his suite in tow arrived there the medical officer in charge of a large hospital upon being told how the governor had lost the greater part of his control over the Sultan by telling him about the x-rays, suggested that during the conference the following day the Sultan should be taken on a tour of inspection through the hospital in order that he might see with his own eyes the things about which he had been told. This plan was adopted, and on the following day the Sultan of Sulu, accompanied by his attendants all clothed in their most gorgeous trappings, arrived for the conference.

At the proper time the tour of inspection through the hospital was begun. The medical and surgical wards, the laboratories and surgical operating rooms were all visited in turn. Finally, the Sultan and his retinue of attendants were ushered into the x-ray department where they were told that the American physicians would now actually show them the bones of their hands just as the military officer had told them could be done. At once the lights in the room were shut off and the x-rays were turned on. The Sultan was called to come forward and see his own bones. Tremblingly he complied and when he saw the image of the bones of his own hand on the fluoroscopic screen he nearly collapsed from fright. After he had recovered his equanimity to some extent he forced the leading members of his retinue to come forward and view their own skeletons.

After considerable talk with his attendants, he explained to the Americans that now he understood what great advances they had made and he pledged anew his allegiance to the Stars and Stripes. Since that day in the dark fluoroscopic room of a Manila hospital, the American authorities have had little trouble with the Sultan of Sulu.

This use of the x-rays by the medical officer in charge turned the tide of diplomacy in favor of the American authorities and thus avoided the necessity of sending an armed force to subjugate the Sultan's people. Thus this diplomatic method saved the lives of many American soldiers and secured the hearty cooperation of the Sultan of Sulu more effectively than could have ben accomplished by armed combat. This appears to be the first record of the use of x-rays in diplomacy.

A Course in Physiotherapy

THE next course of instruction in Physiotherapy will be given at Walter Reed General Hospital, Washington, D. C., beginning October 5, 1923, and continuing for a

period of four months. It is open to women who have had at least two years of training in an approved school of Physical Education. For further information, apply to: The Commanding Officer, Walter Reed General Hospital, Washington, D. C. Attention Department of Physiotherapy.

Midyear Meeting

THE MIDYEAR MEETING of the Radiological Society wil lbe held in San Francisco, June 22nd and 23rd, the Friday and Saturday preceding the meeting of the American Medical Association.

Those desiring to appear on the program should write to Dr. L. T. LeWald, St. Luke's Hospital, New York City, who is chairman of the program committee, or to Dr. R. D. Carman, President of the Radiological Society. The program is almost complete so immediate action is imperative.

The meeting will be held in Polk Hall of the Civic Auditorium, which has a seating capacity of 1,200. Commercial exhibits will be arranged in wide corridors immediately adjoining the meeting hall, and the scientific exhibits to two reception rooms each about 18 by 30 feet, through which one must pass to reach the meeting room.

Dr. W. E. Chamberlain, Stanford University Hospital, San Francisco, is local chairman of the committee on scientific exhibits and would like to have an exhibit of films from as many men as possible. If films can be mailed to him in advance it will greatly facilitate the work of the committee.

The Palace Hotel has been selecetd as headquarters and 100 rooms have been set aside for use of Society members. The prices of rooms are $8, $9 and $10 a day for two in a room. All rooms have baths. We are informed that those desiring accommodations should write at once since reservations are already at a premium.

Dr. M. P. Burnham is chairman of the local entertainment committee. Preliminary arrangements so far made by this committee are for a dinner and dance at the Palace Hotel the night of June 23rd. For Sunday, the following day, a motor trip is planned to the Santa Cruz big trees where luncheon will be served, thence to the beach at Santa Cruz. This trip comprises a scenic drive of about 100 miles each way. Golfers should note the kindness of Dr. Lloyd Bryan, Butler Building, San Francisco, who will, if notified, make arrangements for any member to play on the local golf courses. Dr. Bryan also announces that visiting cards will be issued to the Olympic Club, one of the attractions of which is the swimming pool. Besides these entertainments and courtesies the committee has arranged trips to Mt. Tamalpais, to the campus of the University of California and to that of Leland Stanford University.

DEPARTMENT of TECHNIQUE

The Design of Potter-Bucky Diaphragm Grids*

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IN AN experimental study of the various factors governing the performance of the Bucky diaphragm grid, there appeared to be only one feature of design where appreciable improvement could be made on existing models, and that was in regard to the distance between the patient and the film.

It is a well-known principle in radiographic technique that the part radiographed should be as close as possible to the film, in order to obtain the sharpest definition and detail, and to minimize distortion; for instance, in x-raying the frontal sinuses, the forehead rather than the back of the head is placed in contact with the film holder or cassette.

Undoubtedly one of the reasons why Dr. Potter succeeded where others had failed was that he brought the distance between the patient and the film to a point where it gave improvement in definitions as well as in contrast. This factor seems often to be neglected or ignored in the construction of Bucky diaphragms as well as in the various types of plate changers. In the models of the Bucky diaphragm that I have had opportunity to examine, the distance between the cover of the diaphragm and the film ranges from 7/8 to 1¼ inches. Where the grid itself is only ⅜ or ½ inch thick and the total distance between patient and film is 1¼ inches it is evident that much space is wasted; it is surely unnecessary to allow ¾ or 7/8 inch clearance for the motion of the grid.

The experimental investigation showed that the distance between the patient and the film had a marked effect upon the definition, and that to get the best definition this distance should be made as small as possible. It also follows that to get this same excellence of definition over the whole area of the radiograph, the cassette should follow the curvature of the grid, thus bringing all portions of the film as close as possible to the patient (Van Allen).

The problem in Bucky diaphragm design is to make the grid as thin as possible, and at the same time make the ratio of slit width to slit depth as small as possible.

In attempting to put into practice the conclusions of this study, two experimental Bucky grids have been constructed; the first has been described in a recent publication; the second is an improvement upon the first in that it is a finer meshed grid. By placing the lead strips closer together a higher efficiency in the removal of scattered radiation was produced and a higher radiographic contrast was secured. The cover is made of 1/32 inch aluminum. the grid itself is 0.16 (nearly 3/16) inch thick; the lead strips are three-thousandths of an inch thick and are held in place by strips of celluloid twenty-five thousandths of an inch thick. Supporting the grid over its whole area is a sheet of aluminum two hundredths of an inch thick, fastened at its edges to the aluminum frame. The ratio of slit width to slit depth is practically 1 to 6. The top of the

*—Read at the Annual Meeting of the Radiological Society of North America, Detroit, Dec. 8, 1922.

curved cassette is of 1/32 inch aluminum. The clear space to be allowed above and below the grid depends upon how nearly the surfaces approach true cylindrical surfaces. It was found in this case that when the cover of the diaphragm and the cassette were so adjusted that the grid could travel without touching them that the distance from the upper surface of the cover to the film was 3/8 inch. Probably by increased care in construction this distance could be slightly reduced.

Comparison of the performance of this grid with that of commercial models showed clearly the advantage of the thin grid and curved cassette in giving sharp definition and fine detail. Radiographs were made of the same patient with the experimental diaphragm and with one of the ordinary type, using the same intensifying screens and giving the two films the same development, so that differences in the radiographs were due only to differences in the diaphragms. Several of these radiographs are shown in the scientific exhibit, and it is believed that an examination of these will demonstrate the value of reducing the distance between patient and film to the lowest practicable minimum.

In assembling the experimental grid, some difficulty was experienced in getting the lead strips lined up properly, and probably such a fine meshed grid would be rather expensive to manufacture. The writer would recommend the following dimensions as being the finest and thinnest that could be constructed without special difficulty: Thickness of grid 1/4 inch; lead strips four or five thousandths of an inch thick, separated by strips of wood or celluloid forty or fifty thousandths of an inch thick. With such a grid, the distance between patient and film need not exceed 7/16 inch or 1/2 inch at the most, which is about half that of the average Bucky diaphragm at the present time. Such a grid would be quite efficient in removing scattered radiation, and by reason of the improvement in definition and detail, the usefulness of the Bucky diaphragm would be extended to types of cases where it cannot now be used with advantage.

CASE REPORTS

An Unusual Case of Tuberculosis

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H. S., laborer, aged 48, born in Iceland, began in November, 1918, to have symptoms of pulmonary tuberculosis. These included cough, expectoration, dyspnea and sweats.

On admission to Manitoba Sanatorium in January, 1919, he had well marked, moderately advanced pulmonary tuberculosis of the left side. Bacilli were found in the sputum. By June symptoms had cleared up and he had gained twenty-five pounds in weight. Against advice he went home, saying that he felt as well as ever, and gradually he increased his exertions until he was working eight or nine hours a day.

In May, 1920, he became suddenly ill. When readmitted to Manitoba Sanatorium on June 14th, he had already lost twenty-five pounds in weight, was suffering from general malaise, severe chills and sweats, temperature very definitely and constantly of the "reverse" type, high in the morning, low in the evening, sometimes with an excursion of eight degrees in the day. He complained of general soreness, aching bones, headache, and was restless and sleepless.

When admitted the only marked symptoms definitely referable to the intestinal tract were anorexia and occasional slight abdominal pain. Later he had gastric discomfort and vomiting after taking solid food. On milk diet he had very little digestive disturbance. Bowels were slightly constipated. There were no marked signs of active pulmonary disease. A perirectal abscess of sudden onset, when opened, discharged foul pus. Leukocyte counts ran from 12,000 to 24,000.

The abdomen was flaccid, somewhat distended with gas, but was not tender. Upon deep palpation a sausage-like mass was found in the epigastrium.

Plates after barium meal showed the stomach high, the lower border at the

Fig. 1—Barium meal, as seen in the plate taken at once.

Fig. 2—Barium meal, as seen in the plate at six hours.

level of the second lumbar spine, and a very striking defect in filling corresponding to about one-third of the pyloric end. The stomach was fairly movable.

With a diagnosis of malignant disease the patient was removed on September 17th to a general hospital where he died six weeks later.

A postmorten examination was made by Dr. S. J. S. Peirce of Brandon Man. from whase notes the following extracts are taken:

"All peritoneal surfaces were found studded with firm yellow nodules and the greater omentum was thickened by an accumulation of these. There was no sign of reaction around these nodules. They were suggestive at first sight of a general carcinomatosis of the peritoneum.

"The retroperitoneal and mesenteric lymph glands were universally enlarged and on section showed general soft caseation. The head of the pancreas was largely replaced by caseous glands and, bulging forward from it into the space between the transverse colon and the stomach, and dimpling the greater curvature of the latter, was a mass the size of a hen's egg. It was adherent to the stamach, and the stomach wall to a distance of one half inch from the mass was livid and indurated. Attempts to separate it from the stomach wall showed that the latter was perforated at this point by the mass which projected into the lumen of the stomach, and was there covered by a red pultaceous material which was in relation to an eroded blood vessel, and which was presumably a semi-digested blood clot. The mucosa of the pyloric end of the stomach in its posterior wall and lesser curvature was a sloughing necrotic mass with ill-defined borders. The appearance: Section of the mass showed caseous material which did not differ from the caseous glands at the head of the pancreas and elsewhere. The duodenum was patent and contained no tumor.

"*Diagnosis:* Phthisis pulmonalis tuberculous mesenteric adenitis, caseous tuberculous glands in head of pancreas with fistulous invasion of stomach, tuberculous peritonitis."

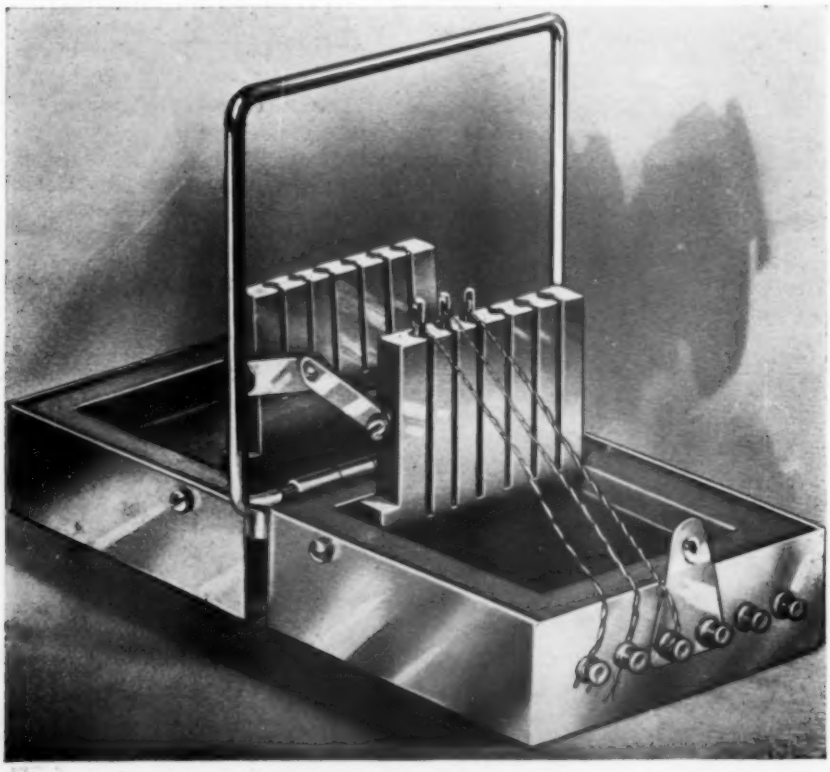
NEW EQUIPMENT

A New Holder for Radium Needles

Described by JOHN R. RANSON, M. D.
Invented by CHAS. H. HULL
The Radium Company of Colorado
Denver

THIS case provides a handy and compact means for carrying and sterilizing radium needles.

The object of this holder is to provide a container which shall be well adapted for retaining radium needles for transportation, for sterilization, and in proper position for threading without direct handling by the operator.



It closes like a cigarette case and the needles stand (points down) in slotted holes and may readily be threaded without removal from the case.

Briefly, the container comprises a holder or casing of two movably connected sections adapted to be folded together, provided with two needle retaining blocks so adapted that they may be automatically swung to and from a collapsed position as the casing is closed or opened. When the casing is opened the needles and the retaining blocks will be presented in vertical position and will maintain this position while the casing is open. In this manner the needles may be threaded without being handled or being removed from the retainer. A bail which serves to carry the holder when open also serves as a pintle for the connecting hinges.

When the container is in open position the two blocks containing the needles are disposed in horizontal alignment as shown in the cut; the backs of the sections engage one another to maintain this relation. The bail also assumes the upright position so that the device may be carried or dipped or even

boiled for sterilization. Small knobs or posts are provided on the outer forward wall of each section around which the ends of the threads or wires may be wrapped to avoid tangling, during sterilization.

Thus the device provides a means for the reception of radium needles, which properly presents the needles for threading, for sterilization and for ready access to individual needles for use. The slotted holes permit the sterilizing fluid to freely circulate about each needle.

When the device is closed the needles are retained in their sockets by the adjacent forward walls of the pockets into which they retreat as the device is closed.

The outer covering of the case is made of nickel-plated copper. This case is lined with one centimeter of lead which protects the operator from the soft rays emitted by the radium contained in the device.

This case is made up in two sizes. The smaller case holds twelve needles and when closed measures one inch thick, two inches wide and two and one-half inches high. The larger case holds sixteen needles and when closed measures one and one-fourth inches thick, two and one-half inches wide and three inches high.

The Victor Phototherapy Lamp

THE Victor X-ray Corporation has this to say with respect to its new Phototherapy Lamp:

As a preliminary announcement of this new Victor development, the following report from our research and engineering departments gives a comprehensive idea of the purposes in mind in the design of the lamp, the extent of experimental work and research involved, and the ultimate achievement.

As distinguished from the physiologic depression consequent to an exposure to radiations that are converted into heat, the visible radiations of luminous light exert a supportive and exhilarating constitutional activity.

The distribution of radiation issuing from tungsten filament lamps is Infra-red and Visible (White) Light.

It is desirable that the energy striking the patient be as nearly as possible a maximum of visible light. It is therefore necessary to provide a special ventilating design that will quickly dissipate the bulk of the heat produced by the infra-red radiation.

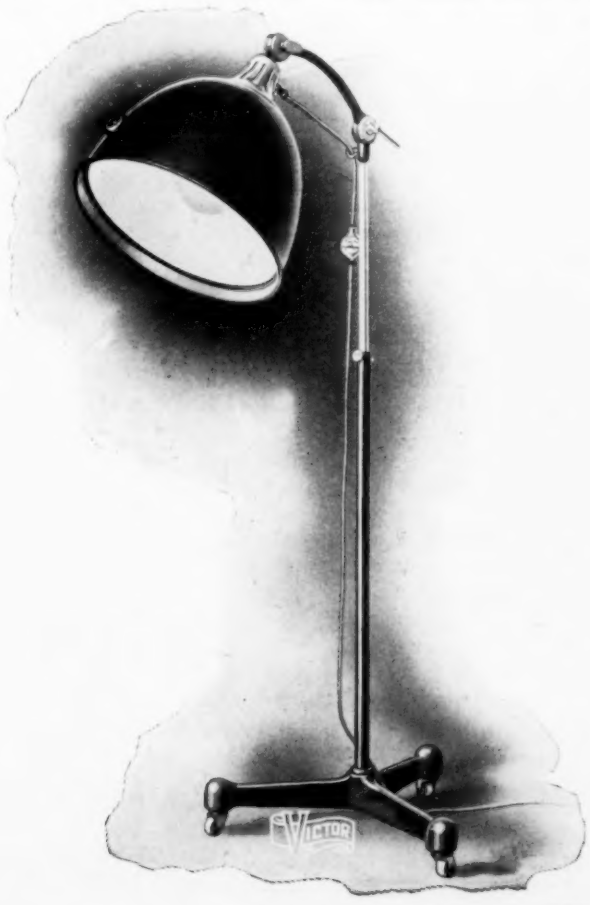
The Victor Phototherapy Lamp holds a new design designated as a double concentric paraboloid reflector.

The reflector holds two jackets of the same design, an outer and an inner, entirely separated excepting at the attachment at the apex. The inner reflector presents an enameled and fluted surface, a combination agreed upon by illuminating engineers as the most desirable for the maximum insurance of dispersed reflection. That is to say, a breaking up of the ray so that a minimum portion of it is reflected back to the filament; thus avoiding the overheating of the filament and prolonging the life of the bulb. This effect can be obtained only through correct design of the reflector. The fluted surface of the internal reflector in the Victor lamp offers this decided advantage.

The space between the two channels amounts everywhere to about one-half inch and insures a continuous circulation of air which acquires a gentle flow and serves constantly to dissipate a great proportion of the heat.

This construction insures an efficient display of visible light with minimum heat accompaniment; conservation of practically all the reflected energy; elimination of reflex rays striking the tungsten filament of the lamp, which condition if present, lessens the useful light of the lamp (this breaking up of the reflection is obtained by the flutings on the internal reflector); complete absence of a thermal focal spot.

Especial care has been made in the selection of the illuminating bulb to in-



sure a glass that will transmit a maximum of useful rays.

The design and proportion of the Victor tungsten filament bulb are such as to make it in every way practical and convenient for every clinical usage indicated. With this unusual practicability it combines an extremely pleasing and finished appearance.

In this latest therapeutic creation the features presented accentuate the desirable qualities that make phototherapy successful; and it is fair to say that no other equipment exists in which the scientific evaluation of the factors that make for clinical efficiency have been more forcefully inculcated in the engineering evolution of the product than has been the case of this lamp. These high standards of scientific attainment are apparently responsible for the superior clinical excellency that may be derived from the use of the outfit.

The Victor Phototherapy Lamp is furnished on floor stand, or with wall bracket if preferred.

ABSTRACTS and REVIEWS

Diathermy in Pneumonia—A Report of Ten Cases. Harry Eaton Stewart, M.D., Med. Herald 42:90, March, 1923.

THE author reports these cases from his consulting service in the U. S. Marine Hospital, No. 21, New York.

In the hospital the results of diathermy treatment of pneumonia cases have led to the adoption of this form of therapy immediately upon the diagnosis of pneumonia being rendered.

Laboratory reports and clinical records, etc., accompany these ten reports. The relief consequent upon diathermy is listed as remarkable in all cases, the temperature in each one fell by lysis immediately after treatment. Two to three treatments per day can be given if proper technique is observed.

The author while rather conservative in his conclusions states that it is the belief of the entire medical staff that diathermy was of great aid in all these cases, and that the employment of this form of therapy in pneumonia cases is justified by results here recorded.

Relative Value of Surgery and Roentgen Ray in the Treatment of Hyperthyroidism. Edward P. Richardson, M.D., J.A.M.A. 80:820, March 24, 1923.

CASES of thyroid disease fall into two classes, those classified upon a basis of function (excessive or reduced), and those classified on a basis of pathologic changes in the gland itself. Chief among the latter are hypertrophy, hyperplasia, deposition of colloid, presence of adenomas, of malignancy or of inflammation.

This article is concerned with the type of case which shows an associated constitutional disturbance, seemingly due to a toxemia. The cause of symptoms, as far as known, is an increased output of thyroxin. This increased thyroid activity nearly always is found in exopthalmic goiter and in adenomatous goiter with hyperthyroidism.

In the Massachusetts General Hospital cases of hyperthyroidism are in charge of a committee made up of two clinicians, one roentgenologist and three surgeons. This committee began thus to function in October, 1919. They believe that the results in their cases justify the use of x-ray therapy in selected cases, namely, those where symptoms are an increased metabolic rate, rapid heart action, nervousness, loss of weight and weakness. Contraindications are "goiters with normal or reduced function requiring treatment for deformity, pressure on adjacent structures, potential malignancy, or potential hyperthyroidism * * *." There must be adequate modern x-ray equipment with ability to measure dosage and the means (basal metabolism, clinical observation) of estimating the benefit obtained must be employed in order to prevent myxedema being produced. An open mind that will employ surgery if necessary to a cure should be the property of every roentgenologist.

The x-rays, says the author, will accomplish the cure of a certain percentage of cases. In others it will make operation possible. "The harm that needs to be visualized comes, I believe, to these improved patients, through damaging effects of a slight persistent hyperthyroidism. The stage of improvement without cure I believe to be the serious phase of roentgen ray treatment; it should be constantly borne in mind." In another place he says: "My feeling is that they go on receiving organic damage, and that their life and usefulness is shorter than it would be from the more complete cure possible by surgery."

An X-ray Study of the Absorption of Tuberculous Exudate Within the Lung. Kennon Dunham, M.D., *and* Vera V. Norton, M.D. Am. J. Roentgenol. 10:112, February, 1923.

IN A total of 489 cases of bronchopneumonia observed at the Cincinnati Tuberculosis Sanatorium during the year from July, 1921, to July, 1922, absorption of tuberculous exudate was observed in 59 cases which the authors unhesitatingly diagnosed as pulmonary tuberculosis. Six of these cases are reported in detail in the original paper.

The authors state that it is their belief that caseous tubercles in the human being can heal by resolution and finally disappear completely.

Roentgen Diagnosis of the More Important Tumors of the Long Bones. Bernard H. Nichols, M.D., Surg. Gynec. Obst. 35:301, September, 1922.

BONE tumors may easily be diagnosed roentgenoscopically by means of the following plan and classification:

I. *Origin:* a. Medullary—Sarcoma, carcinoma, hypernephroma, myeloma, fibroma, bone cyst, echondroma, giant cell sarcoma.

b. Cortical—Periosteal sarcoma, osteosarcoma, osteoma, enchondroma, ossifying hematoma, myositis ossificans, bone cyst (rare), exostoses.

II. *Bone Production*—Periosteal sarcoma, osteosarcoma, osteoma, exostoses, ossifying hematoma, myositis ossificans, enchondroma, bone cyst after fracture.

III. *Condition of Cortex:* a. Expanded—Enchrondroma, bone cyst, giant cell sarcoma, fibroma.

b. Destroyed—Sarcoma, carcinoma, hypernephroma, myeloma, periosteal sarcoma.

IV. *Invasion:* a. Invasive—All malignant tumors.

b. Not Invasive—All benign tumors.

It may not always be possible to determine each of these points but usually two or more of the cardinal points may be learned from the plate and will aid in the process of elimination. These

points, however, do not apply to flat bones or to the vertebrae.

Bone destruction and bone production may be determined. The former may be considerably altered by surgical interference or by trauma.

Location can always be determined. Sarcoma is usually located at the end of the bone, carcinoma will more often be found at the point of entrance of the nutrient foramen. Cartilage seems to be a barrier; malignant tumors do not cross a joint and, therefore, if the lesion involves both sides of the joint it is benign. Age, of course, is an important factor in differential diagnosis.

A malignant tumor originating in the medullary canal develops by cell division, invades the cortex of the bone and the surrounding tissues and produces a spherical growth.

Infectious processes extend up and down the medullary canal, following the Haversian canals and leaving areas of healthy bone. After the infection subsides new bone formation will appear at the periphery of the lesion producing dense periostitis and a thick cortex. In malignancy there are no abating symptoms to allow repair.

A benign tumor will expand the cortex which will be kept intact by a small amount of new bone formation. A thin dense line will be seen at the limit of the lesion in the medullary canal. These lesions tend to present a rather cylindrical contour extending up and down the medullary canal.

About four pages of text accompanied by 15 illustrations describe the main points in the pathological characterization of the following bone lesions: (1) Sarcoma, round cell, spindle cell, periosteal and osteosarcoma. (2) Carcinoma. (3) Myeloma. (4) Benign tumors: giant cell sarcoma, bone cysts, fibromata, chondro-osteoma, osteochondroma, osteomata, exostoses, ossifying hematoma, myositis ossificans. (5) Tuberculosis. (6) Syphilis.

Periosteal Sarcoma in Association with Osteomyelitis. Report of Three Cases. R. L. Rhoades, A. B., M. D., F. A. C. S. Surg. Gynec. Obst. 35:440, October, 1922.

THREE cases of large round cell sarcoma of periosteal origin, associated with infection and necrosis of bone are here reported. In one of these cases the author feels sure that osteomyelitis preceded sarcoma. The report is inspired by Dr. Bloodgood's alleged statement that he had never observed sarcoma in osteomyelitis.

All three patients were females, two were white girls aged 12 and 14 years, and one was a colored girl of 20 years of age. Each case involved the left tibia.

There was in no case a history of trauma or illness. Two of the patients experienced local pain, the other did not. All three showed a staphylococcus aureus infection. Two had a rapid pulse and a high fever.

Mid-thigh amputations were performed upon all three. One patient is dead, the other two are well at present, more than a year after treatment.

A Roentgenographic Study of the Sella Turcica in Normal Children. Murray B. Gordon, M.D., F.A.C.P., *and* A. L. Loomis Bell, B. S., M.D. Endocrinology 7:52, January, 1923.

THE four pages of text are summed up in the following conclusions: "(1) *Shape of the sella turcica.* The sella turcica in normal children can be classified in a general way by means of the roentgenogram into three groups according to shape: *A*, circular; *B*, oval; and *C*, flat and saucer shaped, with modifications as explained in the text. Groups *A* and *B* were found in all ages, while group *C* was practically limited to the first three years.

"(2) *Shape of sella as to size of the head.* The shape of the sella has no significance except in the case of the flat group *C* type. This type is always found in small heads, but it does not necessarily follow that all small heads exhibit this type.

"(3) *Size of sella in comparison with age of the child.* There is a marked variation for each age, both as to height and length of the sella for that particular age. The average height and length of the sella shows a comparatively rapid increase in the first two years with a gradual yet irregular increase from then on up to the age of 12. There is a tendency for the average height increase to follow the average length increase.

"(4) *Size of sella as to size of head.* There is apparently no relationship between the size of the head and the size of the sella based on head measurements.

"(5) *Appearance and size of sella as to sex.* There is no difference in the occurrence of the three groups between the heads of boys and girls. There does not seem to be any influence of sex on either appearance or formation of the sella. The sella of girls, however, were greater in both length and height."

Secondary Os Calcis. Arthur Krida, M.D. Am. J. Roentgenol. 10:752, February, 1923.

DR. KRIDA reports the removal of a secondary os calcis which had become loosened in its situation and which predisposed the patient to recurrent sprains of the right foot. The pain and swelling were localized on the dorsum in front of the external malleolus.

Dwight's *Variations of the Bones of the Hand and Foot* is quoted on secondary os calcis. Dwight and also Geist are credited with having found two such bones; Pfitzner in the examination of 840 feet found 16 such bones.

The author's conclusions are as follows: "From the clinical standpoint, the separate ossicle described by Pfitzner may be accepted as the typical secondary os calcis. Its occurrence in two per cent of his large series of dissections need not lead to the expectation of finding it frequently in routine roentgenograms of the foot, as the smaller and less well developed specimens might easily escape demonstration.

"It would seem that a well developed secondary os calcis, acting like a wedge in a series of complicated movements in the middle of the tarsus would be peculiarly liable to avulsion or displacement."

Some Observations on Radium Therapy in Cancer at the Institute of Radium, Paris. Malford W. Thewlis, M.D. Rhode Island M. J. 6:39, March, 1923.

THE Institute of Radium of Paris University has been made "the foremost center of the world for the study of radium" by the fact that Madame Curie's laboratory is there associated with the biologic laboratory of Dr. Regaud.

Dr. Regaud's collaborators at the Pasteur Laboratory are Drs. Lacassagne, Jolly, Ferroux and Coutard. Experiments upon animals and the histologic examination of patients' tissues are all made here. At the Pasteur Hospital Dr. Regaud is assisted in making applications of treatment by Drs. Cesbron, Monod and Richard, while the emanation tubes used are prepared daily under Madame Curie's direction.

Dr. Regaud's technique is different than that prevailingly used and his work in connection with carcinoma of the tongue and the uterus is said to be remarkable.

Histologic examination of every case is made before treatment. The principle of treatment is destruction of all cancer cells without producing any grave lesion of the anatomic elements of the growth itself or of the tissues surrounding it.

Though 100 mgs. of radium for 10 hours represents the same dose as does 10 mgs. for 100 hours, yet a difference in intensity and time will produce different results according to the type of

lesion under treatment. Regaud's rules for intensity are given as follows: "(1) Tubular epithelioma of the cervix, with the intensity of 100 to 150 microcuries of emanation per hour per focus. (2) Globo-cellular sarcomata and lympho-sarcomata with the intensity of 50 to 100 microcurie hours. (3) Carcinomata of the breast with the intensity of 25 to 50 microcurie hours. (4) Epidermoid epithelioma and tumors of connective tissues rich in fundamental substances, with the intensity of 5 to 25 microcurie hours.

"One should seek to obtain the desired result in one treatment only * * * because in the course of successive treatments healthy tissues become more and more vulnerable while the cancerous tissue becomes more and more unaffected."

Regaud and his collatobators are said to be probably the first to use a radiation of feeble intensity prolonged for from four to ten days without interruption.

The reason for this prolonged treatment is that cells are most sensitive to radioactivity at the moment of nuclear division and to complete the cycle of destruction the radiation must be prolonged. No ill results by way of reaction or sloughing will follow if proper filtration is used. "The secondary rays produced by the various metals used for filters are capable of doing much damage, but if platinum gold and aluminum are used the secondary rays cause little harm. In surface applicators the lead filters the beta rays of the radium, and the aluminum and cork filter the secondary rays produced by the effect of radium on the lead."

Regaud, in certain cases, used bare emanation tubes, but most often he uses platinum iridium needles containing tubes of radium emanation though he prefers salts of radium because of their greater constancy and plans to use the salts entirely as soon as a large enough supply can be procured.

In radium puncture for cancer of the tongue local anesthesia renders the procedure practically painless. The needles are left in place for eight days, the dose being "20 to 20 millicuries destroyed in eight days" (one millicurie of emanation of radium destroyed is the equivalent of 132 milligram hours with radium sulphate).

Regaud believes it is of no practical value, in cancer developing from syphilis, to give treatment for syphilis.

Regarding cancer of the lip his conclusions are as follows: "* * * epidermoid cancer of the lips is curable by roentgenotherapy and by Curietherapy (radium therapy) even when the neoplasm has reached a great development. Curietherapy is in every respect preferable to roentgenotherapy. In thin cancers, Curietherapy by superficial application suffices; in thick cancers radium puncture is more satisfactory or even indispensable. The very good results obtained in cancers which had greatly outgrown the possibility of operation permit us to consider as easy the cure by Curietherapy of cases operable and *a fortiori* the cases in the beginning." Good technique is indispensable. Glandular operations if operable must be treated surgically.

In uterine carcinoma a filter of 0.2 Al in a blind catheter of pure gum rubber is used and the dosage varies according to the type of lesion. Gold tubes with 15 per cent platinum are also used in these lesions.

A Plea for Radiation as an Alternative to Surgery. D. de Vos Hugo, M.B., C.M., South African Med. Rec. 21:29, January 27, 1923.

RESULTS secured by radiotherapy in cases of epitheliomata, carcinoma of the esophagus, uterine hemorrhage and cancer of the cervix are recounted.

Pancoast, Abbe, Quick, Janeway, Biggs, Gussenbauer and Hotzknecht are cited as authorities upon the treatment of epitheliomata, and Beck and John G. Clark upon carcinoma of the esophagus, W. J. Mayo and Howard Canny Taylor upon carcinoma of the cervix.

The author concludes by a general statement regarding the limitations of radium, followed by a plea for unbiased consideration of its merits.

Anatomical Cross-Section Charts in Estimating X-Ray Dosage. Arthur U. Desjardins, M. D. Am. J. Roentgenol. 10:134, February, 1923.

DR. DESJARDINS says that to correctly administer x-ray therapy requires (1) "Knowledge of the location, extent and type of the tumor, and its relation to surrounding structures, as well as of the existence and location of metastatic foci. * * * (2) Knowledge of the quantity of rays of a definite quality, or of 'effective wave-length' necessary to deal successfully with a given type of tumor. * * * (3) Knowledge of the absorption or penetration characteristics of rays of a given 'effective wave-length.'"

There is no such thing as a "cancer dose." There is not enough known about the biophysical and pathological phases of tumor growth and about the quantitative and qualitative effects of x-rays on different tumors to make knowledge of a cancer dose possible.

If the roentgenologist is sufficiently trained in the use of physical instruments and can intelligently use the data obtained by his own efforts he may figure the penetration for himself, and the author has worked out anatomical and cross-section charts by which the ratio of depth dose to skin dose may be determined with relation to the average human figure.

Composite contour tracings at nine different levels were made of 12 female and 12 male subjects, and these were used in making the charts which "will assist the radiologist in applying or studying penetration data with relation to the average patient, but will not remove the necessity or advisability of measuring patients, especially such as are patently larger or smaller than the average. By means of a measuring chartg raduated in centimeter squares and printed on transparent celluloid, it becomes a simple matter quickly to obtain any measurements desired."

The original paper is illustrated with reproductions of cross-section charts.

Deep X-ray Therapy. Reginald Morton, M. D. Am. J. Roentgenol. 10:119, February, 1923.

DR. MORTON of London in this paper characterizes the work of Sitz and Wintz as the "first complete system of x-ray therapy having a sound physical and biological basis," and as the first real step toward a "cure for cancer." Tribute is also paid to Dessauer's charts.

Dr. Morton emphasizes tellingly the fact that the roentgenologist who is a master of his specialty will get a higher percentage of favorable results than will the mediocre man, though the latter may have all the very latest equipment in the market. As an illustration of his point he narrates the story of the famous Edinburgh surgeon who, in a case of emergency, excised an astragalus with only his pocket knife and a screw driver. The subject of the operation walks with a scarcely perceptible limp and the operation, from every point of view, has been a great success.

Three remarkable cases are reported from the writer's practice. One was a case of carcinoma of the breast, one a carcinoma of the esophagus, one a case of malignant prostate, and one a sarcoma of the thorax. These all received x-ray therapy, and though they were all regarded as hopeless at the time of the first treatments, March, 1921, to January, 1922, they are now clinically well.

Some of the Essentials of Dental Radiography. R. A. Albray, D.D.S. Dental Cosmos.

AFTER proper technique in taking dental films the next thing is their proper interpretation, "a task which at

times assumes the proportions of a Chinese puzzle." This is the point at which it is necessary to discriminate between a poor film and a good one and between one good enough for the purpose and one quite worthless.

"Some radiographs are, when studied with the clinical findings of the case, possible of almost instant diagnosis; others have to be carefully inspected with the magnifying glass, and several films of the area must be taken from varying angles, with different lengths of exposure and tubes of hard and soft quality before a satisfactory diagnosis can be made.

"In studying radiographs do not confine yourself to the condition of the bone about the teeth to the exclusion of everything else. Rarefied areas are only a part of the story which the radiograph tells, and every dark spot at or near the apex of the root of a tooth is not necessarily an abscess or focus of infection. * * * When examining a radiograph some of the particular conditions which should be looked for aside from the favorite rarefied area are thickening of the bone about the root apices due to traumatic occlusion, pyorrheal absorption of the alveolar process, carious cavities in the teeth, secondary caries under fillings or the edges of crowns, pulp stones, exostosis of the roots, fragments of roots of extracted teeth, impacted or unerupted teeth, foreign bodies, necrotic or cystic areas.

A few of the physiological structures to observe and not confuse with pathological conditions are the mental foramen, inferior dental canal in the mandible, the anterior palantine canal, antrum, nasal cavity, coronoid process of the mandible. * * * Do not mistake areas about young teeth just erupting or recently erupted for abscesses. Teeth which have been undergoing orthodontic manipulation will frequently show what appears to be pathological lesions in the bone about their root apices."

For the sake of progress the author urges that clinical and radiographic findings be compared with the actual conditions found upon operation.

Indications for Radiodontic Examinations. L. R. Mann, D.D.S. International J. Orthodontia.

THIS author in urging the necessity of x-ray diagnosis says: "* * * in most cases the only way I know to tell whether a complete x-ray is necessary is to make the examination first." Too frequently it is thought that if the tooth responds to the vitality test then x-ray is not needed, but apical abscesses are not all that the x-ray may reveal; in fact, the use of the x-ray in diagnosis will eliminate 75 per cent of guess work on the part of the dentist. The x-ray is absolutely necessary to determine periapical abscesses. In root canal work guess-work is eliminated by intelligent use of the ray. An x-ray is advisable in all cases of so-called pyorrhea.

Attention is called to the less common uses of the x-ray as required in restorative work, etc.

Injuries from Roentgen Rays in Deep Therapy. Herman Wintz, M.D., Erlangen, Germany. Am J. Roentgenol. 10:140, February, 1923.

LOCAL injuries from the x-ray result from exceeding the limit of tolerance of tissues and from the defects of present radiation technique. The expert and conscientious man will not limit his work to poorly trained attendants and he will notice at once any disturbance in the apparatus. X-ray burns will, therefore, not be likely to occur in his practice though they cannot be avoided with absolute certainty.

The varying density and size of the body part irradiated increases the difficulty of administering proper dosage. Values obtained by the water phantom cannot be the exact equivalent values for a like volume of the human body because of the varying composition of different tissues.

In treating cervical cancer the bladder should be emptied every hour during the radiation, otherwise its anterior wall may approach too near the rays, and blistering, edema, or even ulcer may result. The posterior rectal wall in thin patients may also be easily injured as it lies within reach of three fields of entrance.

The small intestine is less likely to be injured but it may be if some of the loops have become fixed by pelviperitonitic adhesions to each other and to the uterine tumor.

In treating the supraclavicular glands and the lymphatic chains along the sterno-cleidomastoid muscle the larynx and the trachea may be injured. This danger is particularly marked if both sides of the neck must be rayed with a dosage of 95 to 100 per cent at a depth of two centimeters, for if the two fields converge at the center then 150 to 160 per cent will strike the laryngeal mucosa. In some types of cases this danger may be avoided by raying only one side, with an interval of several days before the other side is treated. This, however, cannot always be done, for example, in laryngeal carcinoma with infiltration of adjoining parts.

Additional radiation intensity due to uncommon secondary radiators, such as remnants of a barium meal, or collargol, or fecal masses may produce trivial injury; but more or less severe injuries may result from persistent pressure upon the irradiated part, e. g., from the corset, the application of icebags, hot compresses, or from chemical changes resulting from use of internal remedies, from traumata or acute or chronic disease present at the time of radiation.

Irradiated tissues have a lessened resistance if the quantity of rays applied has exceeded, by so much as one-third, the limit of tolerance typical for the cells.

The knowledge of these areas of lessened resistance is of great importance, "for it explains the peculiar injuries which have been observed after correctly applied treatments, and particularly the so-called late injuries."

General injuries are those done to the blood and those which result from inhalation of the air of the x-ray room. Chronic injuries to the blood are due to the effects of the x-rays as well as to this air.

Radiotoxemia deserves more attention and serious study than it has so far received. Actual changes in the biochemistry of the cells take place, disturbing their function, and there is a nervous factor involved. If the patient is grounded or screened by a faradic cage the radiotoxemia is less severe.

Clinical Results of Treatment of Malignant Diseases by X-rays. Lancet 204:185, January 27, 1923.

A DISCUSSION of this subject took place January 22nd, at a meeting of the Medical Society of London.

Dr. Robert Knox in his discussion said that no true estimate of the efficiency of x-ray treatment could yet be given. Surgery he believes must be the first recourse whenever it is possible. X-ray is a very helpful adjuvant to surgery and a palliative in hopeless cases. He warned his hearers against inaccurate diagnosis, e. g., he believes that syphilis is at times inexcusably mistaken for malignancy. Of late Dr. Knox has adopted the practice of giving a small preliminary dose of radiation to determine the patient's reaction. He thinks it is perhaps better to divide the large dose into six sittings with a day or two between each one. This method is being successfully followed at the Cancer Hospital in London. The new method of massive dosage produces a more rapid result but is risky and more uncomfortable for the patient and moreover, to stand it well, the patient's general condition must be very good.

Advances in Radiation Therapy of Deep-Seated Tumors. Rollin H. Stevens, M.D. J. Michigan M. Soc. 21:124, March, 1923.

THIS paper gives a brief review of the physics and history of radiation therapy.

The Angstrom unit is defined and the various wave lengths of the different forms of electro-magnetic waves are given from the wireless wave to the gamma wave lengths of radium rays.

The advancement in the technique of radiotherapy is lightly sketched and the problems of present day radiotherapy are discussed. A generalized report is given of cases of malignancy treated by this author.

He summarizes his view of cancer therapy thus: "In spite of the development of radiation the surgeon is still needed in the cancer world. * * * We doubt the expediency of radical operation in most cancers for the following reasons: (1) The removal of all the reproductive elements of cancer by the most radical surgical operation is probably impossible in the great majority of cases. The history of the surgical treatment of cancer substantiates this statement. (2) There is much evidence that the connective tissues about a cancer are important factors in the cure of the disease and their help can be greatly increased by stimulation with radiation. These tissues, therefore, should not be removed surgically or destroyed by any other means. (3) Radiation destroys cancer cells, directly or indirectly. Whether directly or not it probably stimulates the connective tissues about the growth so that they proliferate, crowd out the cancer cells, and possibly secrete immunizing biological substances against cancer. (4) Metastases are usually more sensitive to radiation than the primary growth. An exception to this is where the metastases is in the neck. Therefore, if surgery is required we believe it should be limited to the primary growth, and sterilization, so to speak, of the cancer field should be left for radiation to accomplish."

Pre-operative radiation four to five weeks before surgery, the author, believes, is better than postoperative radiation. The field is safer for operation and though immediate healing may not be as rapid as it otherwise would be the ultimate result is just as good.

High voltage x-ray therapy of deep seated cancer "should probably be used in preference to surgery in all cases of cancer of the uterus, about the mouth, and in inoperable cancer in other regions. In cancer of the breast and in several other locations it should probably be used in conjunction with non-radical surgery."

The Actinic Ray. Howard A. Plank, M. D. From a paper read at Omaha December, 1922.

THE author says this of the ultraviolet rays: "Don't depend upon the ultraviolet rays alone for every disease and case, because it will not cure your cases. I do not like the word 'cure.' If we arrest some of these things it is all that we can do. Many get well and you may have a recurrence in six months, or years. They get rid of their symptoms, their digestion is all right and they are happy.

"Use everything else you know to be of any benefit to that particular type of case. There is no reason while using ultraviolet rays to exclude any drug you have ever used, because one does not interfere with the other."

He reports successful treatment of psoriasis, though not every case will yield to treatment. Abscess in osteomyelitis, mastoids refusing to heal after operation, erysipelas, old varicose ulcers, lupus and light tuberculous lesions are among the conditions and diseases that he has successfully treated with the ultraviolet rays. He reports a case of stitch abscess following an appendectomy which was greatly helped by ultraviolet treatment.

Pernicious anemia and hay fever while relieved to some extent, the author does not regard as very amenable to ultraviolet treatment.

He warns against using these rays upon boils until after drainage is established, after that they aid in the recovery.

Drawing attention to the research work at Johns Hopkins which has proved that the ultraviolet rays are as efficacious in rickets as is codliver oil he cites a case of anemia where the hemoglobin of 15 per cent was brought up to 40 per cent within thirty days and the red cell count greatly increased, and he remarks that there is no doubt of the general systemic improvement under ultraviolet treatment.

Differences Between Thermotherapy Light and Actinic Rays. T. T. Harris, M. D., *and* R. E. Mowen. From a paper read in Omaha, December, 1922.

IN A technical discussion Mr. Mowen said that the term, "actinic ray lamp," is inaccurate when an ultraviolet ray lamp is meant. Ultraviolet is one form of actinic rays. Neither should the term "deep therapy lamp" be used when a thermotherapy lamp is meant as the latter applies to rays between 4040 and 7700 Angstrom units and the former does not apply to these rays.

Ultraviolet rays besides having a bactericidal and a stimulative effect have two other effects, namely, they raise the opsonic index and increase the general metabolism.

In the general discussion following this paper the subject of treatment of varicose ulcers by ultraviolet therapy was brought up. It was agreed that in cases where environment or temperament made it impossible to keep the patient in bed that the ultraviolet rays would heal the ulcer, without, of course, any effect upon the etiology, but with the ulcer healed and proper support provided the patient could be made comfortable.

Dr. Mullins reported that he had found that eczemas and ringworms would disappear almost magically by the use of ultraviolet rays. The importance of dietary treatment in eczema was stressed.

Actinic Therapy in Rickets and Malnutrition. Newell Jones, M. D. From a paper read at Omaha, December, 1922.

IT IS stated in this paper that 65 per cent of the children under eighteen months of age who live in the middle western part of this country have rickets in some degree or other, and that this condition is found much more frequently among children of the well-to-do than among the poor.

Dr. Jones believes with Bifield and Dean that early rickets predisposes to later chronic upper respiratory infections. Rickets produces deformities which prevent sinus drainage, produces a hyperemia of the mucous membrane throughout the whole gastro-intestinal tract, and results in a general muscular relaxation. All these conditions make the child much more susceptible to colds.

Hess of New York who uses direct sunlight in the treatment of rickets has secured most happy results. Pure codliver oil and the actinic ray will accomplish the same results. Direct sunshine must be from outdoor exposure and the whole body must receive a good coat of tan from the treatment to be of any effect, therefore this is an unfeasible method in any but a warm climate as the sunshine must be unfiltered by glass. In his treatments Dr. Jones uses the air cooled lamp. Exposure at first is from one-half to three-quarters of a minute at a distance of from 20 to 24 inches, the child lying prone and the treatment being given both front and back. To avoid frightening the child it is taken into the treatament room but not given any treatment the first time, so that it may grow accustomed to its surroundings there.

Two treatments per week are given at first and the number is gradually increased until one is given every day.

Distances must not be less than 10 to 18 inches. Some children can be worked up to a three and one-half minute exposure, one must be guided in this by the reaction. The whole body must be stripped, the eyes are protected by gogggles or a bandage. The fair-skinned child as a rule can stand only about fifty per cent of what a dark-skinned child can receive.

In two or three weeks results will begin to show in better appetite, better functioning of the gastro-intestinal tract and a cessation of the sweating which is so characteristic in these cases. Later on the teeth will begin to hurry along, but bow legs, the doctor remarks, are not made over in a day. The hemoglobin percentage and the red blood cell count are greatly increased by the treatment.

Every case of rickets in a child, under eighteen months of age, treated by Dr. Jones has improved if given a fair trial. Two very extreme cases are reported as cured. After eighteen months of age treatment will accomplish nothing except to build up the general nutrition of the body.

Actinic Therapy as a Bactericidal Agent. M. Wood, M.D. From a paper read at Omaha, December, 1922.

ULTRAVIOLET rays stimulate the glands of the skin and this effect together with their bactericidal effect is why they are of such value in the treatment of skin diseases. The water cooled lamp is more bactericidal than is the air cooled one.

In treating acne the writer treats portions of the face, about two and one-half inches square, at different times. No filter is necessary, of course, but he is careful to avoid an erythema of the ear. The pus is first expelled by mechanical means and then fifteen to twenty minutes raying is given with the deep therapy lamp. This is followed by intense treatment with the water cooled lamp to secure a regenerative erythema. This process is repeated twice a week and when the consequent scaling is quite completed another dose may be given if the condition seems to require further treatment. The cure is permanent.

Skins vary in their reaction but the most harm one can do is to blister the skin heavily as in sunburn. The author advises light dosage at first for if a heavy blistering dosage is given the patient becomes alarmed, however, if a heavy dosage seems necessary the patient should be warned what to expect.

Ulcers due to bacteria yield to ultraviolet therapy. Local treatment is given with the water cooled lamp using the one or one-half inch localizer. This is immediately followed by a general body treatment front and back with the air cooled lamp. Intensive local treatment is advised for these lesions, despite the discomfort caused.

Corneal ulcers have been successfully treated. Light raying is used, so pressure is not employed. In a case reported in this paper exposure for one-half minute at close contact was given, which resulted in clearing out the pus; a second treatment was given on the second day with one minute exposure. Complete healing resulted.

Further Observations on the Radium Treatment of Cancer of the Esophagus with a Review of Forty-four Cases So Treated. Walter Mills, M. D., *and* John B. Kimbrough, M. D. Am. J. Roentgenol. 10: 148, February, 1923.

THIS paper reports the results of radium treatment in 44 cases of cancer of the esophagus.

The technique and dosage used are given in detail in the original paper. Most of the patients were lamentably late cases, none were what might be called very early ones.

No case has resulted in cure, nor is any cure expected in the present status of therapy, but the authors are hopeful of the future. The treatment is unquestionably palliative, it lessens the agonies of thirst and hunger and prolongs the lives of those treated. In all but three of the cases dysphagia was relieved, very strikingly in some cases. The longest duration of life after treatment was three and one-half years, another patient lived two years and four months, and another one lived one year and seven months. All other deaths (thirty-four in all) occurred within a year after treatment.

Preliminary Report on the Treatment of Pertussis by the X-ray. Henry I. Bowditch, M.D., *and* Ralph D. Leonard, M.D. Boston M. & S. J. 188:312, March 8, 1923.

ROENTGENOTHERAPY has been tried by the authors in 26 cases of active pertussis. The patients ranged in ages all the way from three months to 40 years of age and were in varying stages of the disease. Three or four applications of the ray were given at intervals of two to three days. The dosage was regulated according to the age and the total given was well under the erythema dose.

The results secured cannot be attributed to accident, say the authors, and they are now making further study of this form of therapy and the results of the study will be reported as soon as ready for publication.

Meanwhile the preliminary account reports that in a few cases after two or three applications of x-ray the spasms and whoops disappeared entirely and the patients were clinically well. On the other hand a few patients secured no relief whatever. Seventy per cent were relieved in that the spasams decreased markedly, patients who had had from 14 to 18 spasms in the twenty-four hours being relieved to the extent of having only one or two a week.

A Case of Primary Carcinoma of the Female Urethra Treated with Radium. Lawrence A. Pomeroy, M. D., *and* Frank W. Milward, M. D. Surg. Gynec. Obst. 35: 355, September, 1922.

THE total number of reported cases of primary carcinoma of the female urethra the author found to be 67.

Urethral caruncle, a common affection in women, may be followed by malignancy; hence, its early recognition is important.

Radical extirpation of the urethra is seldom necessary but when it is it should be thorough, even to the extent of resection of the bladder if necessary.

All operations should be followed by radium; Kelly and Burnham are quoted as two authorities who recommend this procedure. Advanced cases may be relieved by radium or x-ray treatment.

Diathermy in the Treatment of Tumors of the Lower Urinary Tract. B. C. Corbus, M. D. J. Urology 9:203, March, 1923.

FULGURATION and diathermy are thus described: "Fulgration or dessication is produced by the unipolar action of sparks of high frequency and high tension (Oudin's current), and produces only a carbonization of the tissues, thereby lessening heat penetration. Thermic electrocoagulation (diathermy) is the application of thermic properties of bipolar currents of very high frequency and low tension (d'Arsonval current)."

Ten minutes exposure to 113° F. renders impossible the successful transplantation of malignant cells but normal tissue cells can stand from 132° to 140° F.

The technique is described with the aid of diagramatic drawings.

The author's conclusions are that: "Diathermy can be used to destroy cancer in areas that are totally inaccessible by any other procedure. In order to accomplish successfully the destruction of malignant tumors with

thermic-electrocoagulation we must use a current that is low in voltage and high in amperes, only enough voltage being used to drive the current through the tissues. This of course varies in different parts of the body. In coagulating tumors of the bladder by the low infusion of heat 1500 milliamperes are as a rule sufficient."

The general discussion following the reading of this paper brought out many useful points in technique.

The Treatment of Cancer of the Bladder by Radium Implantation. George Gilbert Smith, M. D. J. Urology 9:217, March, 1923.

DIRECT application of radium to the surface of the growth in cases of cancer of the bladder has not yielded satisfactory results in the author's experience, and so in November, 1919, he began the practice of implanting tubes of radium emanation in nearly all cases. The results in some cases have ben very encouraging and in some others very discouraging.

Sloughing resulted in infection and the death of several patients. To avoid this the patient's probable resistance to infection must be taken into consideration and "in less favorable cases use a smaller dose of radium, drain the bladder longer after operation, support the circulation and promote diuresis."

The method of application has been "by intravesical or transvesical approach in small tumors, and by cystotomy and implantation under full sight in more extensive growths."

A brief summary of 11 cases is given and the pitfalls encountered in their history are noted. The author's conclusions are as follows:

"The implantation in bladder cancer of bare tubes of radium emanation of low potency, or of radium bearing needles of 5 mgm. each, will cause complete necrosis of the tumor, provided they are inserted 1 cm. apart and are so placed that the entire periphery of the growth is brought within reach of rays of lethal power. (2) Two classes of cases are suitable for this treatment: small single papillary carcinomata into the base of which bare emanation tubes may be deposited by intravesical methods; sessile carcinomata or the bases of large fungating growths after destruction of the tumor by cautery, into which radium may be implanted through a suprapubic cystotomy. (3) It is inadvisable to bring about the necrosis of a tumor more than 3 or 4 cm. in diameter, as the absorption of toxins from the infected slough is likely to prove fatal. (4) The problem in treating cancer of the bladder by this method is to use enough radium to destroy the cancer but not enough to destroy the patient. (5) A number of cases of cancer of the bladder in whom the growth could not have been excised successfully, have shown complete disappearance of the growth, clinically, following the implantation of radium."

A New Method of Applying Radium Through the Cystoscope. Leo Buerger, M. D. J. Urology 9:227, March, 1923.

THE author believes that he has perfected an intensive and efficacious method of applying radium, a method that will eliminate the necessity of leaving the cystoscope in the bladder.

Special needles and applicators are used with either the author's operating cystoscope, a direct or oblique vision cystoscope, or the author's oblique vision radium cystoscope. Technique and apparatus are described in detail.

Dr. Buerger says, "Time will not permit me to discuss at length all the correct indications for the use of radium in the bladder. But as a urologic surgeon, and one who has treated carcinoma of the bladder almost exclusively in a surgical manner for more than fifteen years, one who has been able to witness the results of partial resection with or without unretral reimplantation, complete cystectomy and cauterization, I can unqualifiedly express the opinion that not only has the cystoscopic application of radium a sphere of usefulness, but that radiosurgery—the combined administration of radium and surgery—is the best therapy at our disposal today for such malignant growths.

"As for cystoscopic radium therapy its field is three fold: First, for the treatment of carcinoma alone without surgery; second, for the treatment as a preliminary step to surgery; third, for the treatment of metastases."

A report upon cases so treated is contemplated for the near future.

Electrotherapeutics in Prostatic Conditions. Victor Cox Pedersen, M.D. J. Urology 9:249, March, 1923.

THIS paper is a historical and critical review of the work of the urologist and electrotherapeutist during the last quarter of century.

The writer states that "in general all prostatism must be recognized as to the fact and degree of congestion, inflammation, abscess, hypertrophy, neoplasm or calculus." After certain pathological changes have occurred electrotherapeutics cannot confer any permanent benefit.

Twenty-five pages are taken up with the description of faradism, galvanism, sinusoidalism, ionization, static wave, high frequency and radiotherapy.

In the early days of electrotherapeutics those using it paid too little attention to the pathology of the disease treated and to diagnostics, consequently recognition of the usefulness of the method was retarded. The author says, "It is unfortunate that a method as important as electrotherapeutics should have been more or less disqualified by imperfect apparatus and improper applications and careless selection of cases in the past." He also says, "If progress in medicine is to be uniform, methods of treatment recommended by one specialty must be carried out strictly in accordance with directions, otherwise one group of observers will succeed and the other group will fail in exactly similar cases of pathological processes."

Studies on the Changes Produced by Roentgen Rays in Inflamed Connective Tissue. Alexander A. Maximow, M.D. J. Exper. Med. 37: 319, March, 1923.

THE changes produced by the x-rays in connective tissue elements are unknown but the author infers that they must be of great importance from the fact that the connective tissue is inevitably involved in all forms of roentgenotherapy. Ribbert believes that x-ray carcinoma is the result of changes in the connective tissue exposed to x-rays. Fraenkel believes that the loose connective tissue is a single large endocrine system.

The topics discussed are: Material and methods; granulation tissue and the exudate layer surrounding the foreign body; changes in the blood vessels; changes in the muscles; inflammation in previously exposed connective tissue and the action of x-rays upon scar tissue.

For more than twenty years this author has made a special study of the inflammatory changes in connective tissue; in 1919 he began certain studies upon the effect of x-rays upon inflamed connective tissue and this paper is a report of that experimentation, which was done upon rabbits. The work is not yet complete.

Flat celloiden blocks with slits cut parallel in their surface were introduced into the subcutaneous loose connective tissue of the abdominal wall to induce aseptic inflammation, and the area above these was rayed once a day for a certain period. A filter of 0.5 Al was used with Gundelach or Mueller type tubes at a distance of 14 to 15 cm. Daily exposure lasted about fifteen minutes. The dose was about 12 Kienboeck's quantimetric units.

Quite a detailed histological description is given of the changes found upon examination after raying, a part of which is here quoted: "It is surprising that the results seem not to agree with the predominating views of the action of x-rays upon cells. Apart from the endothelium of the blood vessels, of all the cells present in the field of inflammation the fibroblasts are undoubtedly to be considered as the elements most highly differentiated in a specific sense. I have shown that as a rule they do not round up in inflammation and do not produce ameboid cells but remain unchanged in morphology, and through mitotic division give rise to the new connective tissue. On the other hand there can be no doubt that the lympocytes and the polyblasts are to be looked upon as relatively indifferent cells, endowed with great prospective potencies of development. Thus it might be expected that just the lymphocytes of the inflamed area would be affected in the first place by the rays, as they are in the blood forming organs, and that the fibroblasts, on the contrary, would be refractory.

"But the facts have proved that the most conspicuous and constant changes concern the fibroblasts. They are paralyzed for a long time and made unable to build up new tissue. The fibrinous exudate and the edema might perhaps also depend partly on a direct injury of the colloidal intercellular substance, partly on changes of the endothelium of the blood vessels, cells which are again to be considered as highly differentiated."

Hertwig's researches proving that the nucleus with its chromatin is the most affected of all the parts of the cell was confirmed.

Neither the inflammation stimulus alone nor the x-rays alone in the doses given were able to produce the changes noted. Only the combination of the two, in either sequence, had such result.

"The strong inhibitory and deleterious influence of x-rays on inflamed connective tissue ought to be kept in mind in the therapeutical use of this kind of energy, especially in cases of malignant tumors, in which the local connective tissue in most cases is found in a state of inflammatory irritation."

Effect of Injection of Active Deposit of Radium Emanation on Rabbits, with Special Reference to Leukocytes and Antibody Formation. Ludwig Hekoten and H. J. Corper. J. Infectious Diseases 31:305, October, 1922.

THE authors decided as a result of certain experiments that "an active deposit of radium is lethal to rabbits when given intravenously in amounts of approximately 8 to 10 millicuries per kilogram weight. In lethal amounts given intravenously the active deposit produces an initial leukocytosis with finally a marked diminution in the circulating leukocytes, mainly the polymorphnuclears. This is associated with changes in the liver, lungs, lymph glands, spleen, suprarenals and kidneys and is frequently accompanied by capillary hemorrhages. These results are similar to those Bagg obtained with an active deposit in white rats and dogs. Given intravenously, active deposits in non-lethal amounts may have a depressing effect on the formation of lysin and to a less extent on precipitin from sheep blood."

High Voltage Therapy in Treatment of Carcinoma of the Breast. Joseph Aspray, M. D. Northwest Med. 22:85, March, 1923.

THE author classifies carcinomas of the breast as (1) primary operable, (2) primary inoperable, (3) recurrent operable, (4) recurrent inoperable, (5) for prophylaxis.

The primary and recurrent inoperable may be rendered operable in a certain percentage of cases. Pre-operative and postoperative treatment is recommended in all operable cases.

Dr. Bloodgood is quoted as giving pre-operative treatment in all evidently malignant breast cases and as advising postoperative treatment after operation involving the glands. Dr. Burton J. Lee of the New York Memorial Hospital and Dr. James T. Case of Battle Creek are quoted as favoring and using pre-operative treatment.

The author writes the following conclusions: "(1) High voltage therapy is of greater advantage and benefit than the older type of therapy. (2) All cases should be carefully examined and if metastasis is found or the mass is adherent radiation should precede operation. (3) All definite malignant cases should be treated with radiation before and after operation. (4) Healing is not interfered with if operation does not follow radiation too soon, and the tendency to infection is not increased. At least four to six weeks is recommended after high voltage therapy before operating."

Pelvic Measurements by X-ray. Alfred Baker Spalding, M.D. Surg. Gynec. Obst. 35:813, December, 1922.

CHAMBERLAIN and Newell of Stanford University Hospital in 1921 published the details of a method of x-ray pelvimetry which they had developed at that hospital. This method is a simplification of that by Runge and Gruenhagen.

The distinctive points in the Chamberlain and Newell method are "a plumb-bob hanging from a lead ring under the target which is set 80 cm. above the plane of the film; second, a wire stretched across under the patient; and third, a 10 cm. rod which is placed on the body of the patient just above the symphysis."

The method is too expensive for routine use but it has been found very helpful in gauging the diameters of the outlet of the pelvis and has at times saved the patient an unnecessary Caesarean section when external measurements had seemed to indicate one necessary. Accurate diagnosis of the position of the presentation part is remarked upon as one of the boons of x-ray in obstetrics.

The x-ray department of Leland Stanford Hospital entered into a contest with the rest of the obstetrical staff (obstetricians, senior and junior staff and students) to see what method yielded most accurate measurements. It was found that certain of the pelvimeters in routine use gave erroneous measurements and that different methods of pelvimetry gave varying measurements. It was also found that sufficient argeement did not exist regarding the exact points from which measurements ought to be made.

The roentgenologist, unless he is also a trained obstetrician, cannot give a reliable prognosis from his measurements alone; he and the obstetrician should consult with each other before prognosis is agreed upon.

Hydatid Cysts of the Heart with Report of a Case. H. W. Mills, M.R.C.S., L.R.C.P., F.A.C.S. Surg. Gynec. Obst. 35:455, October, 1922.

THIS is a report of the postmortem finding of a hydatid cyst, 5 cm. in diameter, in the right ventricle of a thirty-eight year old woman.

The growth had a typical laminated cyst wall. There were no daughter cysts nor scolices but four cysts the size of a walnut were found on the inner side of the lower lobe of the right lung, the other lung being normal.

In these cases the secondary lesions of the lungs may be larger than the primary growth in the heart. A multiplicity of cysts in the lung suggests their secondary origin as does their cortical position. However, metastatic cysts of the lung may be central.

"No case of hydatid cyst of the heart has ever been diagnosed in a living subject though Cerne once rightly suspected one. The x-ray will sooner

or later wipe out this reproach." Cardiac murmurs are not usually evident. Spontaneous cure sometimes results.

The Value of the Roentgen Ray in Cardiac Diagnosis. Frank N. Wilson, M. D. *and* Forrest Merrill, M. D. Am. J. Med. Sc. 165: 340, March, 1923.

THIS detailed discussion covers 16 pages of solid text upon the following topics: Appearance of the heart on fluoroscopic examination; cardiac pulsations; effects of respiration and change in posture; the roentgen ray in the diagnosis of cardiac enlargement; variations in the size of the heart; recognition of enlargement of individual cardiac chambers; hypertrophy and dilatation, cardiac weakness; diagnosis of valve lesions.

The roentgen ray, say these authors, is an invaluable agent in the examination of the heart, provided the ray is used in conjunction with all other known methods of examination. One should neither overestimate nor expect too much of roentgen ray examination. The limitations of inspection, percussion and palpation are well known and therefore these methods seldom lead to gross error; but the roentgen ray, while it is a far more accurate method, has limitations not well known to any but the most expert and experienced in its use and in the hands of the insufficiently informed and over-enthusiastic it has frequently led to mistaken conclusions.

"We must conclude that with the standards at present in use it is impossible for the roentgenologist to diagnose with certainty grades of cardiac enlargement that are not recognized or suspected by the clinician. * * * There is need for a much more comprehensive study of the normal cardiac silhouette than has yet been attempted. In such a study all of the factors known to influence the size of the heart shadow should be included. Not only height and weight but the body surface, the sitting height, the heart rate, the age, the diameters of the chest, the angle of inclination of the long axis of the heart, and the amount of physical exertion to which the subject is accustomed should be recorded so that the influence of each may be determined. The anterior-posterior diameter of the heart and the inclination of its long diameter with reference to the axis of the body should be measured. And finally subjects should be selected with great care and should be re-examined after from two to four years so that incipient cases of heart disease might be excluded; this could easily be done in any medical school, where freshmen could be chosen as subjects and could be kept under observation until after graduation."

Van Zwaluwenburg's method of diagnosing cardiac enlargement from the cardiac silhouette by treating the silhouette as an ellipse and computing the area by multiplying the product of the large and short diameters by 0.7854 is discussed as is also another method by which enlargement is determined from calculations based on the ratio of the total transverse diameter of the heart to the internal diameter of the chest. Another method compares the total transverse diameter of the heart shadow with the average value of the same measurement in the normal subject of the same weight.

In diagnosing valve lesions it is especially emphasized that the roentgenologist should not look upon valve lesions not associated with more or less characteristic alterations of the cardiac silhouette as comparatively unimportant. He should remember that the importance does not depend solely upon the magnitude of the mechanical disturbance produced but upon the nature of the disease process to which it is due.

Neoplasms of the Larynx. Charles M. Robertson, M.D., F.A.C.S. Illinois M. J. 43:210, March, 1923.

A CONDENSED review of the literature is given and the etiology, symptoms, classification and treatment of these neoplasms is discussed.

The author has this to say of other than surgical treatment: "Diathermy has been used with more or less success, although authors vary on the end results, some claim prompt eradication of growths with happy results, while others seem to be disappointed by its use. Of the different forms of heat rays it appears to the author the most favorable of those yet used.

"X-ray is of advantage in controlling the pain in laryngeal growth, but as a treatment alone it seems to be very disappointing, as cases seem to go on in the usual way despite its use.

"Radium has many ardent admirers and I have seen tumors soften for a time under its use; later, however, there seems to be an exaggeration of the spread of the growth and it appeared to me the process was accelerated, rather than retarded and obliterated."

Importance of Indirect Roentgen Findings in Chronic Infection of the Bilary Ducts and Gall-ladder. M. P. Burnham, M. D. Am. J. Roentgenol. 10:105, February, 1923.

THE importance of indirect roentgen evidence at any stage far outweighs that of the direct evidence. The evidence may be divided into two groups: "(1) Changes of form and position seen in the first and second portions of the duodenum, and (2) variations in the normal gastric physiology."

Discussing this evidence the author says: "The first class of evidence, namely, that of change of form and relation in the first and second portions of the duodenum, and due to pressure mainly, although adhesion fixtures cannot be excluded as a cause, consists of clean-cut indentations of the duodenal bulb, crescentic deformities, usually seen on the lateral aspect of the bulb or on the inferior aspect; also irregular deformities of the bulb, not of the crescentic type, and distortion in the course of the descending duodenum amounting in many cases to very great angulation. These gall-bladder pressure deformities are, in a general way, much alike in all cases, changing as to the particular point in the duodenum at which the pressure is most prominently seen, dependent upon the pathology present in the individual case. The angulations in the course of the second portion in the duodenum are quite as characteristic as the indentations in the bulb, in our experience.

The second class of evidence, namely, that of changes in the normal gastric physiology, is most interesting, but not nearly as decisive in character as changes noted in the duodenum. It may be stated that the normal stomach accepts the liquid opaque meal, holding it in the form of a column of about equal width throughout, the pyloric sphincter closing, preventing its discharge into the intestine, and the cardiac sphincter closing, preventing regurgitation of the stomach contents into the esophagus.

"There is frequently seen, in cases of gall-bladder and bile duct infection, a narrowing in the pyloric end of the stomach produced by spasm of the wall, the stomach taking the form of a narrow caliber tube. In other cases is seen a conical-shaped pyloric section, the result of spasm, with apex at the sphincter. This spasm appears immediately upon taking a meal, and may persist for considerable periods of time. When the peristalsis is established it is noted that the waves begin far back on the curvatures and traverse the stomach slowly, often failing to reach the pyloric sphincter. At no time has the antrum a globular shape such as we see normally. This spasm of the pyloric section increases the intragastric tension and, I believe, is the cause of the sensation of fullness and distention of which patients complain."

Studies of the Mechanism of Movement of the Mucous Membrane of the Digestive Tract. Goesta Forssell, M. D., Stockholm. Am. J. Roentgenol. 10:87, February, 1923.

THE prevailing opinion that the folds of mucous membrane of the stomach are caused by the contraction of the muscular coat of the stomach is incorrect, according to Dr. Forssell who believes that the folds are due to active movement of the membrane itself.

He reached this conclusion from a study of "anatomical preparations, series of roentgenograms and photographs of the digestive tract of human beings (living)." The photographs were made possible in a case of ileal fistula, almost 3.5 by 4 cm. in size, which occurred in a fifteen year old boy. The folds of the membrane changed form and position without the exposed surface of the intestine visibly changing its size or form, "and independently of the rhythmical contractions of the muscular coat that passed over the muscular coat almost eight in a minute." Twelve pictures of the surface of this mucous membrane taken within an hour show the different phases of movement, six of these illustrations are reproduced in the original article.

The author also had the opportunity of observing "an exposed surface of a mucous membrane from the colon descendens, in the prolapse of the colon in a colostomy, and could thereby ascertain that, in general, a richer forming of the folds appeared together with an uncreased contraction of the muscular coat, but that the mucous membrane even with very high folding could freely be moved against the underlying muscular coat; that a change of the folds of the mucous membrane as to the number, position and form took place, independently of the contraction of the muscular coat, and that purely local ridges of the mucous membrane have been formed without a corresponding local contraction of the muscular coat."

Summing up the evidence of his studies he says: "It should, therefore, be without doubt that the folds of the mucous membrane, of the colon as well as those of the stomach, duodenum and small intestines are not modeled by a contraction of the muscular coat only, but by autonomous appropriate movements of the mucous membrane."

The motor force of the mucous membrane is the muscularis mucosae and "is able to displace the mucous membrane in all directions by means of transversal, longitudinal and oblique fibers."

A simultaneous contraction of the muscular coat of the stomach may aid in these specific movements of the mucous membrane but "a definite degree of contraction of the muscular coat does not produce a definite corresponding relief of the mucous membrane; on the contrary, a stage of contraction producing a certain width of the muscular tube, can be associated with a relief of the mucous membrane varying from an even surface to a very complicated folding."

A new chapter in the etiology of certain diseases of the alimentary tract will probably be written when research upon the problem is complete.

A Rare Case of Symmetrically United Proximal Epiphyses of the Second Metacarpal in a Child of Three. Dr. B. Gorynkraut. Bull. Soc. de radiol. med. de France 95:28-29, January, 1923.

A THREE year old baby born of healthy Russian parents, was presented, with a complaint of severe pain in the right wrist. There were no signs of inflammation, and the pain was strictly localized at the base of the second metacarpal. A few days later there was a cessation of pain in the right wrist but pain had developed in the left wrist.

Roentgenographic examination revealed a wedge shaped incomplete fissure in the base of each second metacarpal. The presence of an injury was definitely eliminated both by anamnesis as well as by the roentgenographic appearance. Due to lack of trauma, absence of any signs of inflammation, the symmetry of the lesion, and the rapid development and termination of the pain, the author was led to regard this as a disturbance in the process of ossification.

Normally there is only one center of ossification for the shaft of the metacarpal, and one for the distal epiphysis with the exception of the thumb where one sees the reverse, because the proximal epiphyses of all but the thumb metacarpals unite during fetal life. The author concluded that this disturbance in ossification was probably due to lack of vitamines in the mother's food during pregnancy as the parents were then living in famine stricken Russia.

The possibilities of myxedema and mongolism in which such persistence of epiphyses has been described, had to be excluded in this case. Nor were there found any abnormalities in the feet.

A. M. PFEFFER.

Stimulative Roentgen Ray Doses in Alopecia Areata. Dr. Thedering. Deutsch. med. Wchnschr. 49:89-90, January 19, 1923.

THE author is inclined to join that group of investigators which regards alopecia areata and seborrhoea as caused by some microbic agent. Alopecia areata is certainly curable, as the hair follicle is not dead, but only hardened and in a condition of paralysis. In the long standing cases the follicles may have undergone complete atrophy of disuse and the condition is incurable, but in the early cases a sufficiently irritative or stimulative dose will reawaken them to activity.

The three conditions for curability of alopecia areata are:

(1) The follicles must be preserved.

(2) The stimulation must be sufficiently strong, and

(3) Must reach deeply enough.

The inefficiency of the various chemical agents as chrysarobin, etc., is due to their incapacity to penetrate to the follicle. The splendid results obtained in this stubborn condition by radiation with ultraviolet rays are well known. Nogelschmidt had 200 cases, Bering had 100.

Besides that ultraviolet radiation takes often too much time, it is only applicable in cases of easy accessibility, such as in men with short cropped hair, but in women where there is a mass of hair, the lesions cannot be well reached for exposure to ultraviolet rays without much time-robbing preparation. The ultraviolet radiation must be frequently repeated, and at each repetition the time of exposure lengthened on account of the pigment deposit in the skin. Cases of relapse are too frequent in ultraviolet treatment, because the underlying cause, the seborrhoea, has not been affected.

The author found that a radiation on the bearded region of 11 X with ½ mm. Al filter produced increased growth in the first week, stationary growth the second week, and loss of hair in the third week. From this fact it is evident that a fraction of that dose will be stimulative only.

The author found that dose to correspond to the radiation of 1 to 2 X with ½ to 2 mm. Al filtration. As the effect of this dose passes after two weeks, it may be repeated every two weeks until the hair begins to grow again. This dose is given each time in several places, so that the whole scalp is well covered. The seborrhea is treated at the same time during the radiation, which is generalized.

There is no fear of either temporary or permanent epilation, because the depilitory dose is 10 to 12 X while this stimulation dose requires only 1 to 2 X.

The author has successfully used this treatment in more than 100 cases within the last five years.

A. M. PFEFFER.

Grashey—Atlas Typischer Roentgenbilder J. F. Lehmann, Verlag, Muenchen, 1923, Price $4.00.

AS EXPLAINED by the title this book is an atlas of typical roentgenograms of normal individuals. The author, who is one of the members of the editorial staff of the Journal of Radiology, is so well known from his long association with the University of Muenich that he needs no introduction. The book is one which should find a place in the reference library of every radiologist. This issue is the fourth edition of the book. It has been modernized and a number of additions have been made including a chapter by Herr Dr. Voltz on the physics and technique of x-ray production.

The reproductions of roentgenograms are accompanied by a key in black and white line drawings making the interpretation of the x-ray plates exceedingly clear and vivid. Wherever helpful, anatomical wash drawings are used to make the interpretation of the x-ray plate more certain.

There is an abundance of material giving the correct positions when making roentgenograms of various parts of the body. Drawings with angles plainly marked help one to visualize the part being examined. This section will be found especially helpful to the technician as well as the less experienced radiologist.

A table of contents coupled with an alphabetical index, makes it easy to refer to any information desired.

A. F. TYLER.